



MUMBAI METRO RAIL CORPORATION LIMITED

मुंबई मेट्रो रेल निगम लिमिटेड

ENVIRONMENTAL IMPACT ASSESSMENT FOR MUMBAI METRO RAIL CORRIDOR LINE- III (COLABA-BANDRA-SEEPZ)



MMRDA

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FINAL REPORT

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IRITES
THE INFRASTRUCTURE PEOPLE

(A GOVERNMENT OF INDIA ENTERPRISE)

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ABBREVIATIONS AND ACRONYMS

| | | |
|--------|---|---|
| ATP | : | Automatic Train Protection |
| BEST | : | Brihanmumbai Electric Supply and Transport |
| BIS | : | Bureau of Indian Standards |
| BKC | : | Bandra Kulla Complex |
| BOD | : | Biochemical Oxygen Demand |
| CBI | : | Computer Based Interlocking |
| CER | : | certified emission reductions |
| CGWB | : | Central Ground Water Board |
| cm | : | Centimeter |
| CO | : | Carbon mono Oxides |
| COD | : | Chemical Oxygen Demand |
| CPCB | : | Central Pollution Control Board |
| CRZ | : | Coastal Region Zone |
| CSIA | : | Chatrapati Shivaji International Airport |
| CTE | : | Consent to Establish |
| cum | : | Cubic Meter |
| dB | : | Decibel |
| °C | : | Degree Centigrade |
| DMRC | : | Delhi Metro Rail Corporation |
| DPR | : | Detail Project Report |
| E | : | East |
| ECR | : | Environmental compliance report |
| EIA | : | Environmental Impact Assessment |
| EMP | : | Environmental Management Plan |
| EPA | : | Environmental Protection Agency |
| EPR | : | Extended Producer Responsibility |
| ETP | : | Effluent Treatment Plant |
| GHG | : | Green House Gases |
| GIS | : | Geographical Information System |
| gm | : | Grams |
| Ha | : | Hectare |
| HC | : | Hydro Carbon |
| Hz | : | Hertz |
| ICCROM | : | International Centre for the study of Preservation and Restoration of Cultural Property |
| ICOMOS | : | International Council on Monuments and Sites |
| IET | : | International Emission Trading |
| IMD | : | India Meteorological Department |
| IMP | : | Independent Monitoring Panel |
| IS | : | Indian Standards |
| IUCN | : | International Union for the Conservation of Nature and Natural Resources |
| JBIC | : | Japan Bank for International Cooperation |
| JICA | : | Japan International Cooperation Agency |
| JPD | : | Joint Project Director |
| Kg | : | Killograme |
| KLD | : | Kilo Liter per Day |
| KL/Day | : | Kilo Liter per Day |
| km | : | Kilo Meter |
| km/h | : | Kilo Meter per Hour |
| Km/L | : | Kilo meter per Meter |
| Kmph | : | Kilo Meter per Hour |
| KV | : | Kilo Volt |
| KWh | : | Kilo Watt Hour |
| LCD | : | Liquid Cristal Display |
| LED | : | Light-Emitting Diode |
| m | : | Meter |

| | | |
|-------------------|---|--|
| MCGM | : | Municipal Corporation of Greater Mumbai |
| mg | : | Milligram |
| mg/l | : | Milligram per Liter |
| m/Hr | : | Meter per Hour |
| MIDC | : | Maharashtra Industrial Development Corporation |
| MLD | : | Million Liter Per Day |
| mm | : | Millimeter |
| Mm ³ | : | Million Cubic Meter |
| MMR | : | Mumbai Metropolitan Region |
| MMRC | : | Mumbai Metro Rail Corporation |
| MMRDA | : | Mumbai Metropolitan Region Development Authority |
| mm/s | : | Millimeter per Second |
| μm ³ | : | Micro Cubic Meter |
| MoEF | : | Ministry of Environment and Forest |
| MPL | : | Maximum Permissible Limit |
| MPN | : | Most Probable Number |
| MRTS | : | Mass Rapid Transit System |
| MSL | : | Mean Sea Level |
| MT | : | Metric Ton |
| MTNL | : | Mahanagar Telephone Nigam Ltd. |
| N | : | North |
| NATM | : | New Austrian Tunnelling method |
| NFC | : | National Facilitation Committee |
| NGO | : | Non Government Organisation |
| mg/m ³ | : | Milligram per cubic Meter |
| NHAI | : | National Highway Authority of India |
| NO _x | : | Nitrous Oxides |
| OCC | : | Operation Control Centre |
| OP | : | Operation Policy |
| PAP | : | Project Affected People |
| % | : | Percentage |
| PHPDT | : | Peak Hour Peak Direction Traffic |
| PIA | : | Project Implementation Agency |
| PIP | : | Pipe in Pipe |
| PM | : | Particulate Matter |
| PMC | : | Project Management Consultant |
| PSD | : | Power Spectral Density |
| RMC | : | Regional Meteorological Centre |
| RO | : | Reverse Osmosis |
| ROW | : | Right of Way |
| R&R | : | Rehabilitation and Resettlement |
| SEAC | : | State Level Expert Appraisal Committee |
| SEDH | : | Subway Environment Design Handbook |
| SEIAA | : | State Environmental Impact Assessment Authority |
| SES | : | Socio-Economic Survey |
| SO ₂ | : | Sulfur di Oxide |
| SPCB | : | State Pollution Control Board |
| SPM | : | Suspended Particulate Matter |
| sq. | : | Square |
| TBM | : | Tunnel Boring Machine |
| UNESCO | : | United Nations Educational, Scientific and Cultural Organization |
| VOC | : | Vehicle Operating Cost |
| WHO | : | World Health Organization |
| WWF | : | World Wildlife Fund |

CHAPTER – 1

INTRODUCTION

1.1 INTRODUCTION

Mumbai is the financial capital of India and witnessing phenomenal growth in population and employment. The job opportunities it offers have served as a major attraction for immigration from hinterland of Maharashtra as well as from all parts of the Country. Mumbai Metropolitan Region (MMR) is one of the fast growing metropolitan regions in India. It comprises of 7 municipal corporations, 13 municipal councils and 996 villages and extends over an area of 4,355 sq.km. MMR is projected to have population and employment in the year 2031 as 34.0 million and 15.3 million respectively. The dominant feature of the passenger movements in Mumbai is overwhelming dependence of travel on transport modes and walk. In MMR, public transport systems are overcrowded and the road network is congested as there is a large gap between the demand and supply. To decongest the existing public transport systems and increase mobility across the Region, DMRC in 2004 prepared a Metro Master Plan for Mumbai for a length of 149.97 km of network planned for MMR, to be implemented in three phases, Phase 1: 2005-2011, Phase II: 2011- 2016 and Phase III: 2016-2021.

Multimodal access to the airport passengers at CSIA was initially contemplated via line I (Versova – Andheri – Ghatkopar), but the spur line connection was not found feasible. The National Facilitation Committee (NFC), in its meeting held on September 3, 2009, decided that the metro connectivity to the CSIA be expedited and put in the phase 1, rather than in the phase 3 as per Metro Master Plan. This was decided to be achieved by merging Line 6 of Phase 3, named BKC – Kanjur Marg via Airport with the Line 3 of Phase I, i.e. Colaba – Mahim – Bandra and run through services from Colaba till SEEPZ as depicted in **Figure 1.1**.

With this background, MMRDA through MMRC commissioned the services of RITES to update both the studies of DMRC conducted in 2007 for Colaba – Mahim – Bandra Metro Line and Mahim – BKC – Kanjur Marg (2010) and prepare a combined DPR and Environmental Impact Assessment for the running of through services on corridor - Colaba – Bandra – SEEPZ.

1.2 OBJECTIVES AND SCOPE OF STUDY

The objective of the study is to facilitate the Mumbai Metropolitan Region Development Authority (MMRDA) in the preparation EIA report as per requirement of regulatory and funding agency. The scope of EIA includes the impacts resulting from pre-construction, construction and operation phases of Line I Metro corridor, Depot and sub-stations. MMRDA has planned to get fund from Japan International Cooperation Agency (JICA) for the construction of Mumbai Metro Line III.

Image © 2011 Terra Metrics
Image © 2011 Terra Metrics

The MoEF, Government of India, Notification of 14th September 2006 and its amendment dated 1st December 2009 enlist projects in Schedule that require environmental clearance. However as per the said notification a metro project does not require environmental clearance from MoEF.

The scope of the study is framed as per JICA guidelines for Environmental and Social considerations. The objectives of the JICA guidelines are to encourage Project proponents to have appropriate consideration for environmental and social impacts, as well as to ensure that JICA's support for examination of environmental and social considerations are conducted accordingly.

1.3 JICA REQUIREMENT

In its confirmation of environmental and social considerations, JICA places importance on dialogue with all involved partners (e.g. the host country, local governments, borrowers and project proponents) regarding environmental and social considerations. Transparent and accountable processes, as well as active participation of key stakeholders (e.g. local residents and local NGOs) in all stages of the project are highly considered. JICA make clear in their "Guidelines for Environmental and Social Considerations" that these are mandatory to receive JBIC's funding. JICA guidelines are formulated based on the World Bank Operational Policy (OP 4.01). The project has been classified according to its impacts on the environment.

BOX 1.1 EIA CATEGORIZATION SYSTEM IN JICA

Category A Projects are likely to have significant adverse impacts on the environment and society. It includes projects in sensitive sectors or with sensitive characteristics and projects located in or near sensitive areas.

Category B Projects are ones with potential adverse impacts on the environment and society less adverse than those of Category A projects.

Category C Projects have minimal or little adverse impacts on the environment and society.

1.4 LEGAL, POLICY AND INSTITUTIONAL FRAME WORK

Since the adoption of The Kyoto Protocol in December 1997 which was entered into force on 16 February 2005, that developing countries are principally responsible for the current high level of GHG emission into the atmosphere due to industrial activities. This protocol

commits the developing countries to reduce 5 percent pollution against 1990 level over the five years period 2008-12.

The need for a well-developed legal mechanism is to conserve resources, protect the environment and ensures the health and well being of the people in India was felt. Keeping the pace with international laws, the Ministry of Environment and Forest enacted Environmental Protection Act in 1986. Over the years, the Government of India has framed several policies and promulgated number of Acts, Rules and Notifications aimed at management and protection of the environment. During last three decades an extensive network of environmental legislation has grown and presently it has a fairly complex body of environmental legislation aimed at ensuring that the development process meets the overall objective of promoting sustainability in the long run. The available legal Acts and Legislation referred during the study are:

- The Water (Prevention and Control of Pollution) Act, 1974 (Amendment 1988).
- The Water (Prevention and Control of Pollution) Cess Act 1977, (Amendment 2003),
- The Water (Prevention and Control of Pollution) Cess Rules, 1978, 1991.
- The Air (Prevention and Control of Pollution) Act 1981 (Amended 1987).
- Noise Pollution (Regulation and Control) Rules, 2000 (Amendment 2002, 2006).
- Municipal Solid Waste Rules, 2000
- The Environment (Protection) Act, 1986, amended 1991.
- The Environment (Protection) Rules, 1986.
- The Indian Forest Act, 1927.
- Forest (Conservation) Act, 1980, amended 1988.
- Forest (Conservation) Rules, 2003.
- The Wild Life (Protection) Act 1972, Amendment, 2002
- The Metro Railway (Amendment) Act 2009
- Metro Railway (Construction of Works) Act, 1978
- Delhi Metro Railway (Operation and Maintenance) Act, 2002
- The Ancient Monuments and Archaeological sites and Remains (Amendment and Validation Act), 2010

The EIA is conducted as per “Guidelines for Environmental and Social considerations” of JICA. These guidelines are formulated based on the World Bank Operation Policy (OP – 4.01)

The Environmental Impact Assessment covers the proposed on-site activities as well as the transportation of the generated waste to the waste disposal sites.

1.4.1 Water and Water Pollution

The use of water resources and also the discharge of polluted water (sewerage) are primarily regulated by the Water (Prevention and Control of Pollution) Act, 1974 amended

in 1988. The Water Cess Act, 1977 amended in 1992 and 2003, including Rules 1978 and 1991 provides for levy and collection of Cess on water consumed with a view to generate resources for prevention and control of water pollution. The Act assigns functions and powers to the Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCBs) for prevention and control of water pollution.

The Environment (Protection) Act 1986 amended in 1991 and Rules also lays down specific standards for quality of water effluents to be discharged into different type of water bodies (sewers, surface water bodies). Additionally, the water supplied to users for drinking shall also conform to the National Drinking Water Standard, IS-10500 (**Appendix 1.1**). **Appendix 1.2** summarizes the general standards for discharge effluent in Inland Surface Water Bodies. To ascertain and categorize the existing water quality, the results of the analysis of water quality need to be compared with the water quality standards given in **Appendix 1.3**.

Off late, with rapid depletion of groundwater resources in several areas of the country, efforts have been initiated to regulate the use of groundwater resources. The focus of such acts and rules is to provide for mechanisms that would lead to replenishment of groundwater reserves through techniques like rain water harvesting. The Central Ground Water Board, (CGWB) the statutory authority set up by the Central Government has also restricted the drilling of tube wells and bore wells in certain water scarce areas in the country.

1.4.2 Air Quality

The Air (Prevention and Control of Pollution) Act, 1981 and amended in 1987 including Rules 1982 and 1983 was enacted to prevent, control and reduce air pollution. According to Section 21 of the Act, no person shall establish or operate any activity, which can cause air pollution without obtaining Consent to Establish (CTE) as per the Air Act. The Act also lays down National Ambient Air Quality Standards for pollutants like PM_{2.5}, PM₁₀, Sulphur dioxide, Oxides of Nitrogen, Carbon monoxide, Lead, Ozone, Ammonia, Benzene and Benzo pyrene with the intent of managing air quality for different category of areas (residential, industrial and sensitive). Ambient Air Quality Standards have been notified by the CPCB vide Gazette Notification dated 16th November 2009, refer **Appendix 1.4**.

The Extended Producer Responsibility (EPR) also specifies source emission standards determined on the basis of the impact of pollutants on human health, vegetation and property for activities, which can pollute the air. The SPCBs, on a case to case basis, can also make the emission standards more stringent on the considerations of the carrying capacity of a specific air shed and the existing pollution levels of ambient air quality.

1.4.3 Noise Quality

With the objective of regulating ambient noise quality in the environment, the Central Government has notified the Noise Pollution (Regulation and Control) Rules, 2000 amended in 2002 and 2006 under the EPA. The noise standards for different category of areas are based on the weighted equivalent noise level (L_{eq}). The EPR also lays down equipment noise standards for DG sets, Air conditioners and Construction Equipment, which would be in use for the project. Ambient Noise level standards have been notified by the MoEF vide Gazette Notification dated 26th December 1989 and also in the Schedule III of the Environmental (Protection) Rules 1986. It is based on the 'A' weighted equivalent noise level (L_{eq}). These are presented in **Appendix 1.5**.

1.4.4 Solid Waste Management

Project construction and operation generates solid waste at site. The MMRDA would be responsible for collection and handling of solid waste as per the provisions of the Municipal Solid Waste Rules, 2000. The Hazardous Waste (Management and Handling) Rules, 2000 require facilities to classify wastes into categories, manage them as per the prescribed guidelines and obtain prior authorization from the SPCB for handling, treatment, storage and disposal of Hazardous Wastes.

1.5 INSTITUTIONAL FRAMEWORK

The Ministry of Environment and Forests (MoEF) is the nodal agency in the administrative structure of the central government for planning, promotions, co-ordination and overseeing the implementation of India's environmental and forestry policies and programs. The major responsibilities of MoEF include:

- Environmental resource conservation and protection, including environmental impact assessment, clearance of developmental projects;
- Co-ordination with the other ministries and agencies, voluntary organizations and professional bodies for environmental action plans;
- Promotion of research and development, manpower planning and training and creation of environmental awareness;
- Liaison and coordination with international agencies involved in environmental matters.

1.5.1 Central and State Pollution Control Boards

The Central Pollution Control Board 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:

- The planning of comprehensive state programs for the prevention and control of air and water pollution and to ensure the implementation thereof;
- Inspection of pollution control equipment/ plants for monitoring of their efficiency

The SPCB in consultation with the Central Pollution Control Board may establish norms for air quality, gaseous emission and noise level etc.

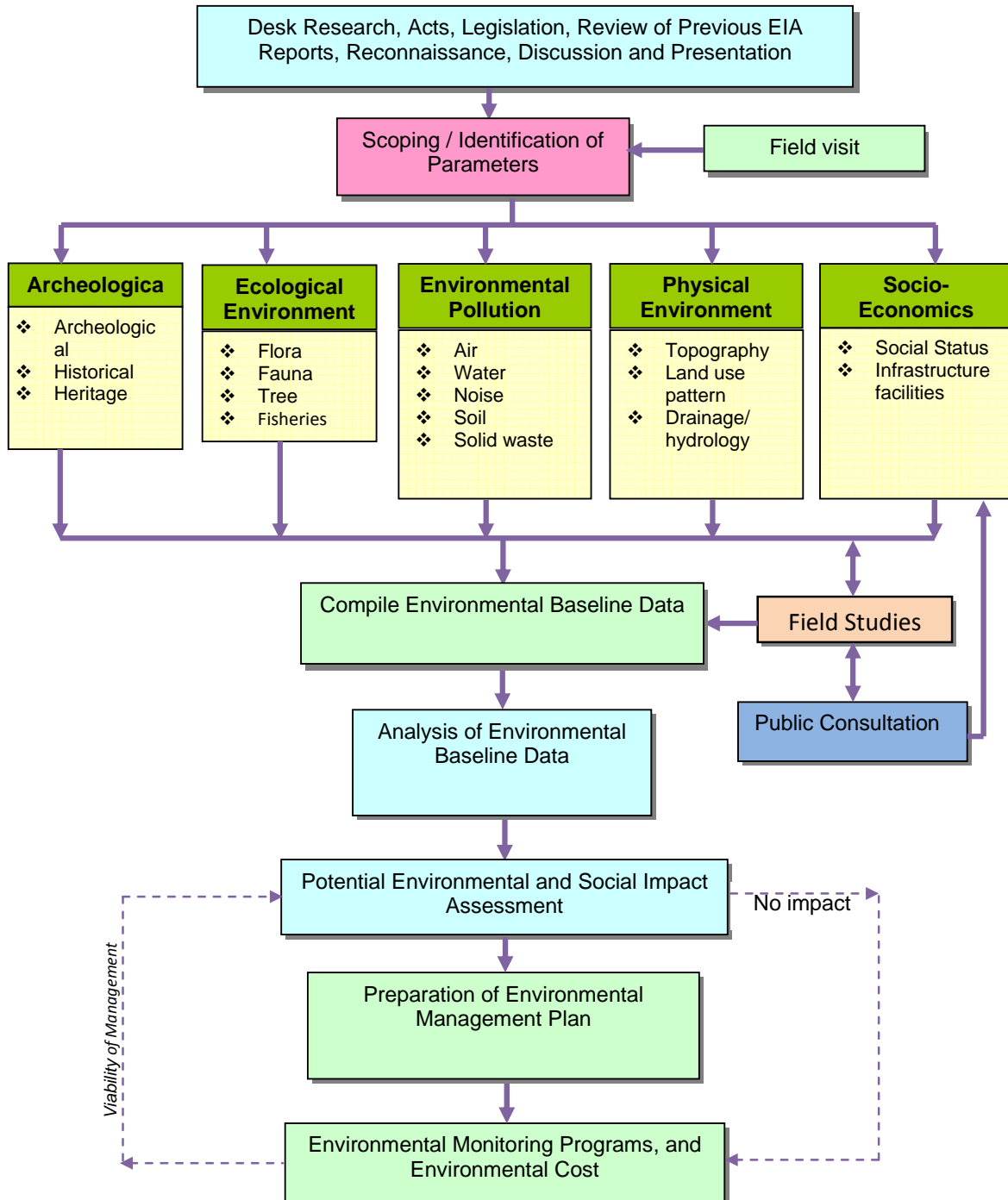
1.6 APPROACH AND METHODOLOGY

The proposed alignment has been fixed based on Technical Feasibility, Socio-economic acceptability, and Environmental sustainability for Metro Corridors. The environmental study is carried out for the final alignment proposed by MMRDA. The **approach** is to follow the sequence of steps adopted in an EIA study. The basic concept is to ascertain the existing baseline conditions and assess the impacts as a result of construction and operation of the project. The changes likely to occur in different components of the environment viz. physical, biological / ecological, environmental and socio-economic etc. have been studied, analyzed and quantified, wherever possible. The identification of parameters for data generation and impact assessment are important. The accurate analysis of assessment depends upon the reliable data generated/ available on environmental attributes. RITES has documented the baseline data for various parameters of physical (physiographic and soils), ecological (forestry, fisheries and wildlife), and environmental pollution (air, water, noise, and solid waste). The impacts are assessed for various phases of project cycle namely:

- Impacts due to project location,
- Impacts due to project design,
- Impacts due to project construction, and
- Impacts due to project operation.

The impacts are categorized as negative and positive. The cost of management and monitoring programs are estimated and budgeted for. The approach for the study is presented in **Figure-1.2**.

FIGURE 1.2
METHODOLOGY FOR THE EIA STUDY



The standard **methodology** for the data collection, impact assessment and formulation of management plans is adopted. The National Acts, Legislation and Laws along with **JICA** and **World Bank** guidelines were consulted with a view to ensure compliance with various requirements. The consultant collected and compiled the environmental baseline data for environmental attributes from primary and secondary sources. The primary sources include site visits, visual inspection, field studies, monitoring and analysis. The secondary sources include the books, reports, maps and documents from various government and non-government organizations on subject matter. The methodology proposed to be adopted for data collection, impact analysis, preparation of environmental management and monitoring plans is highlighted in brief, in the following paragraphs. However, more elaborate methodology is present in the main text in the relevant sections.

1.6.1 Data Collection

The existing **land-use** pattern of the area has been identified mainly as urban human settlements, roads, Trees and water bodies. The **Soils** parameters are studied from the field surveys conducted during this study.

Water Resources in the project were considered in terms of precipitation, surface run off; quantity and quality of water. These will facilitate to decide various uses such as drinking, irrigation etc.

Air and Noise quality is an important consideration during construction and operation phases. Ambient air quality and noise levels were monitored in and around project area to develop present baseline levels in the area. The literature reviews were conducted to establish past air pollution and noise levels in the project area. The future air and noise quality were predicted using mathematical modeling.

Terrestrial **Ecology** was studied. The vegetation types were documented through the visual inspection, past research and field investigations.

1.6.2 Environmental Impact Assessment

The objective of the study is to assess the impacts as a result of construction of the Mumbai metro corridors along with depot and sub-stations. The changes likely to occur in different components of the environment were studied and analyzed. The core area of study is to be 100 m on either side of proposed alignment. Based on project particulars and the existing environmental conditions, potential impacts were identified that are expected to be affected as a result of the proposed project and wherever possible, these are quantified. Both positive and negative impacts are evaluated to have an idea about resultant impacts. These impacts were assessed for various phases of project cycles namely, location, design, construction and operation. The standard methodology was adopted for impact prediction and assessment. Prediction is essentially a process to

forecast the future environmental conditions in the project area that might be expected to occur. The prediction of impacts can be through mathematical modeling, overlays/ super imposition of activity, or comparison of impacts observed. The environmental impact of the project includes changes in land use, soil, erosion, water quality, air quality and noise levels etc. The impact on soils due to disposal of waste water and erosion during storms were predicted. The impact on water quality in the water bodies was evaluated with the help of water quality analysis. The burning issue such as Carbon dioxide emission is also studied. More details on Environmental Impact Assessment are available in **Chapter 4**.

1.6.3 Environmental Management Plan

The project will provide higher living standard, better quality of life, less travel time, better connectivity and transport facilities. The management plans are essential to ensure that stress/ loads on the systems are within carrying capacity. The management plan aims at maintaining the environmental quality of project area. An environmental management strategy/ plans were developed to mitigate the adverse impacts. Efforts are made to enhance the quality of environmental attributes.

1.6.4 Environmental Monitoring

It is necessary to monitor during various phases of project cycles the environmental attributes. Monitoring would indicate any environmental problem, which has come up due to an ongoing activity. This will facilitate to assess the effectiveness of management / mitigation measures. The consultant has designed a post project environmental monitoring program for implementation. The cost estimates for environmental monitoring and management have been included in the project estimates.

1.6.5 Liaison with Authorities

For the preparation of this EIA, the project team and environmental experts have liaised with the MMRDA, and JICA in order to discuss the proposed scope of the EIA, available data in the specific area on environmental attributes and general comments / observations that these authorities may have on the project and its environs. In addition, informal consultations were organized with individuals and nearby people, in order to present the project and collect their views on the perceived positive and negative impacts on the environment on account of this new development.

1.7 FORMAT OF THE REPORT

The main elements of the study are as follows: In **Chapter-2** briefs about the proposed project description & alternatives. **Chapter-3** summarises environmental baseline conditions including physical, biological and socio-economic parameters and pre-project environmental constraint such as air pollution, problems related to public health and traffic

congestion. Potential negative and positive impacts are presented in **Chapters-4 and 5** respectively. These include issues such as loss of land, rehabilitation and resettlement, disposal of soil, loss of trees, noise and vibration, disruption of utilities/ facilities, socio-economic and other problems due to the development of proposed Mumbai Metro Line-III. The detail of Public Consultation for the proposed project has been given in **Chapter-6**.

Based on the anticipated negative impacts, the project may bring about an environmental management strategy, which has been outlined in **Chapter-7**. **Chapter-8** includes post project environmental monitoring programmes. This programme aims at signalling any potential environmental problem during construction and operation of the project and it should allow for timely implementation of corrective measures. The costs of the environmental management and monitoring programmes are presented in **Chapter-9**. The conclusion of the EIA study conducted has been presented in **Chapter- 10**.

The literature, books, reports referred, is detailed in References. Where applicable, more detailed information on methods used is included in concerning paragraphs. The issue related to rehabilitation and resettlement and rehabilitation plan are available in separate report.

Appendix-1.1
DRINKING WATER QUALITY STANDARDS (IS 10500:1991)

| S. No. | Substance or Characteristic | Requirement (Desirable Limit) | Undesirable Effect outside the Desirable limit | Permissible limit in the absence of alternate source |
|----------------------------------|--|-------------------------------|---|--|
| Essential Characteristics | | | | |
| 1 | Colour, Hazen units, Max | 5 | Above 5, consumer acceptance decreases | 25 |
| 2 | Odour | Unobjectionable | - | - |
| 3 | Taste | Agreeable | - | - |
| 4 | Turbidity NTU, max | 5 | Above 5, consumer acceptance decreases | 10 |
| 5 | pH Value | 6.5 to 8.5 | Beyond this range the water will affect the mucous membrane and/or water supply system | No relaxation |
| 6 | Total Hardness (as CaCO ₃) mg/l, Max | 300 | Encrustation in water supply structure and adverse effects on domestic use | 600 |
| 7 | Iron (as Fe) mg/l, max | 0.3 | Beyond this limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures and promotes iron bacteria | 1.0 |
| 8 | Chloride (as Cl) mg/l, Max | 250 | Beyond this limit, test, corrosion and palatability are affected | 1000 |
| 9 | Residual free Chlorine, mg/l, Min | 0.2 | - | - |
| 10 | Fluoride (as F) mg/l, Max | 1.0 | Fluoride may be kept as low as possible. High fluoride may cause fluorosis | 1.5 |
| 11 | Dissolved solids mg/l, Max | 500 | Beyond this palatability decreases and may cause gastro intestinal irritation. | 2000 |
| 12 | Calcium (as Ca) mg/l, Max | 75 | Encrustation in water supply structure and adverse effects on domestic use | 200 |
| 13 | Magnesium (as Mg) mg/l, Max | 30 | Encrustation in water supply structure and adverse effects on domestic use | 100 |
| 14 | Copper (as Cu) mg/l, Max | 0.05 | Astringent taste, discoloration and corrosion of pipes fitting and utensils | 1.5 |
| 15 | Manganese (as Mn) mg/l, Max | 0.1 | Beyond this limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures | 0.3 |

| S. No. | Substance or Characteristic | Requirement (Desirable Limit) | Undesirable Effect outside the Desirable limit | Permissible limit in the absence of alternate source |
|----------------------------------|--|-------------------------------|--|--|
| Essential Characteristics | | | | |
| 16 | Sulphate (as SO ₄) mg/l, Max | 200 | Beyond this causes gastro intestinal irritation when magnesium or sodium are present | 400 |
| 17 | Nitrate (as NO ₂) mg/l, Max | 45 | Beyond this methaemoglobinemia takes place | 100 |
| 18 | Phenolic compounds (as C ₆ H ₅ OH) mg/l, Max | 0.001 | Beyond this, it may cause objectionable taste and odour | 0.002 |
| 19 | Mercury (as Hg) mg/l, Max | 0.001 | Beyond this, the water become toxic | No relaxation |
| 20 | Cadmium (as Cd), mg/l, Max | 0.01 | Beyond this the water become toxic | No relaxation |
| 21 | Selenium (as Se), mg/l, Max | 0.01 | Beyond this the water become toxic | No relaxation |
| 22 | Arsenic (as As), mg/l, Max | 0.05 | Beyond this the water become toxic | No relaxation |
| 23 | Cyanide (as CN), mg/l, Max | 0.05 | Beyond this the water become toxic | No relaxation |
| 24 | Lead (as Pb), mg/l, Max | 0.05 | Beyond this the water become toxic | No relaxation |
| 25 | Zinc (as zn), mg/l, Max | 5 | Beyond this limit it can cause astringent taste and an opalescence in water | 15 |
| 26 | Anionic detergents (as MBAS), mg/l, Max | 0.2 | Beyond this limit it can cause a light froth in water | 1.0 |
| 27 | Chromium (as Cr ⁺⁶) mg/l, Max | 0.05 | May be carcinogenic above this limit | No relaxation |
| 28 | Plynuclear aromatic hydrocarbons (as PAH) g/l, Max | - | May be carcinogenic | - |
| 29 | Mineral oil mg/l Max | 0.01 | Beyond this undesirable and odour chlorination place | 0.03 |
| 30 | Pesticides mg/l Max | Absent | Toxic | 0.001 |
| 31 | Radioactive materials a) Alpha emitters Bq/l max b) Beta emitters pci/l, Max | - | - | 0.1 |
| | | - | - | 1 |
| 32 | Alkalinity mg/l Max | 200 | Beyond this limit taste becomes unpleasant | 600 |
| 33 | Aluminium (as Al), mg/l Max | 0.03 | Cumulative effect is reported to cause demntia | 0.2 |
| 34 | Boron, mg/l, mg/l Max | 1 | - | 5 |

EFFLUENT DISCHARGE STANDARDS (INLAND SURFACE WATER)

| S.No. | Parameter | Unit | Standards |
|-------|---|------|--|
| 1 | Colour & Odor | -- | All efforts should be made to remove colour and unpleasant odor as far as practicable. |
| 2 | Suspended Solids Max. | mg/l | 100 |
| 3 | Particle size of Suspended Solids | -- | Shall pass 850 micron IS Sieve |
| 4 | pH value | -- | 5.5 to 9.0 |
| 5 | Temperature, Max. | °C | Shall not exceed 5°C above the receiving water temp. |
| 6 | Oil and grease, Max. | mg/l | 10 |
| 7 | Total residual Chlorine, Max. | mg/l | 1.0 |
| 8 | Ammonical Nitrogen (as N), Max. | mg/l | 50 |
| 9 | Total Kjeldah Nitrogen (as N), Max. | mg/l | 100 |
| 10 | Free Ammonia (as NH ₃), Max. | mg/l | 5 |
| 11 | Biochemical Oxygen Demand (5 days at 20°C), Max. | mg/l | 30 |
| 12 | Chemical Oxygen Demand Max. | mg/l | 250 |
| 13 | Arsenic (as As), Max. | mg/l | 0.2 |
| 14 | Mercury (as Hg), Max. | mg/l | 0.01 |
| 15 | Lead (as Pb), Max. | mg/l | 0.1 |
| 16 | Cadmium (as Cd), Max. | mg/l | 2.0 |
| 17 | Hexavalent Chromium (as Cr ⁺⁶), Max. | mg/l | 0.1 |
| 18 | Total Chromium (as Cr) Max. | mg/l | 2.0 |
| 19 | Copper (as Cu), Max. | mg/l | 3.0 |
| 20 | Zinc (as Zn), Max. | mg/l | 5.0 |
| 21 | Selenium (as Se), Max. | mg/l | 0.05 |
| 22 | Nickel (as Ni), Max. | mg/l | 3.0 |
| 23 | Cyanide (as CN), Max. | mg/l | 0.2 |
| 24 | Fluorides (as F), Max. | mg/l | 2.0 |
| 25 | Dissolved phosphates (as P), Max. | mg/l | 5.0 |
| 26 | Sulphides (as S), Max. | mg/l | 2.0 |
| 27 | Phenolic compounds (as C ₆ H ₅ OH), Max. | mg/l | 1.0 |
| 28 | Radioactive Materials α Emitters, μcurie/ml, Max. β Emitters, μcurie/ml, Max. | mg/l | 10 ⁻⁷ 10 ⁻⁶ |
| 29 | Bio-assay test | mg/l | 90% survival of fish after 96 hours in 100% effluent |
| 30 | Manganese (as Mn) | mg/l | 2.0 |
| 31 | Iron (as Fe) | mg/l | 3.0 |
| 32 | Vanadium (as V) | mg/l | 0.2 |
| 33 | Nitrate Nitrogen | mg/l | 10.0 |

TOLERANCE LIMITS FOR INLAND SURFACE WATER QUALITY

| Characteristic | Designated Use Class of Inland Waters | | | | |
|--|---------------------------------------|------------|------------|------------|------------|
| | A | B | C | D | E |
| pH value | 6.5 to 8.5 | 6.5 to 8.5 | 6.5 to 8.5 | 6.5 to 8.5 | 6.0 to 8.5 |
| Dissolved Oxygen, mg/l, Min. | 6 | 5 | 4 | 4 | - |
| Biochemical Oxygen Demand (5 days at 20°C), mg/l | 2 | 3 | 3 | - | - |
| Total coliform organisms, MPN/100 ml. Max. | 50 | 500 | 5000 | - | - |
| Colour Hazen units | 10 | 300 | 300 | - | - |
| Chlorides (as Cl), mg/l Max. | 250 | - | 600 | - | 600 |
| Sodium Adsorption ratio Max. | - | - | - | - | 26 |
| Boron (as B), mg/l. Max. | - | - | - | - | 2 |
| Sulphates (as SO ₄), mg/ l | 400 | - | 400 | - | 1000 |
| Nitrates (as NO ₃), mg/l Max. | 20 | - | 50 | - | - |
| Free Ammonia (as NH ₃), mg/l | - | - | - | 1.2 | - |
| Conductivity at 25° C microhm / cm Max. | - | - | - | 1000 | 2250 |
| Arsenic (as As), mg/l. Max. | 0.05 | 0.2 | 0.2 | - | - |
| Iron (as Fe), mg/l | 0.3 | - | 50 | - | - |
| Fluorides (as F), mg/l | 1.5 | 1.5 | 1.5 | - | - |
| Lead (as Pb), mg/l. Max. | 0.1 | - | 0.1 | - | - |
| Copper (as Cu), mg/l | 1.5 | - | 1.5 | - | - |
| Zinc (as Zn) mg/l/ Max. | 1.5 | - | 1.5 | - | - |
| Manganese (as Mn), mg/l | 0.5 | - | - | - | - |
| Total Dissolved Solids, mg/l | 500 | - | 1500 | - | 2100 |
| Total Hardness (CaCO ₃), mg/l | 300 | - | - | - | - |
| Magnesium (as Mg), mg/l | 100 | - | - | - | - |
| Chlorides (as Cl), mg/l | 250 | 600 | - | - | 600 |
| Cyanides (as CN), mg/l | 0.05 | 0.05 | 0.05 | - | - |

Source: Central Pollution Control Board

A: Drinking Water Source without conventional treatment but after disinfections;

B: Outdoor bathing organized;

C: drinking water source with conventional treatment followed by disinfections;

D: propagation of wildlife and fisheries;

E: irrigation, industrial cooling, controlled waste disposal.

NATIONAL AMBIENT AIR QUALITY STANDARDS

| Pollutant | Time Weighted Average | Industrial, Residential, Rural & Other Area | Ecologically Sensitive Area (notified by Central Government) |
|--|-------------------------|---|--|
| Sulphur Dioxide (SO ₂), µg/m ³ | Annual 24 Hours** | 50 80 | 20 80 |
| Nitrogen Dioxide as NO ₂ , µg/m ³ | Annual 24 Hours** | 40 80 | 30 80 |
| Particulate Matter (size less than 10µm) or PM ₁₀ µg/m ³ | Annual 24 Hours** | 60 100 | 60 100 |
| Particulate Matter (size less than 2.5µm) or PM _{2.5} µg/m ³ | Annual * 24 Hours** | 40 60 | 40 60 |
| Ozone (O ₃) µg/m ³ | 8 hours** 24 Hours** | 100 180 | 100 180 |
| Lead (Pb) µg/m ³ | Annual * 24 Hours** | 0.50 1.0 | 0.50 1.0 |
| Carbon Monoxide (CO) mg/m ³ | 8 Hours** 1 Hour** | 02 04 | 02 04 |
| Ammonia (NH ₃) µg/m ³ | Annual * 24 Hours** | 100 400 | 100 400 |
| Benzene (C ₆ H ₆) µg/m ³ | Annual * | 05 | 05 |
| Benzo (a) pyrene (BaP) particulate phase only ng/m ³ | Annual * | 01 | 01 |
| Arsenic (AS) ng/m ³ | Annual * | 06 | 06 |
| Nickle (Ni) ng/m ³ | Annual * | 20 | 20 |

Source: Central Pollution Control Board Notification dated 18th November 2009

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

** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

NATIONAL AMBIENT NOISE STANDARDS

| Category of Zones | Leq in dB (A) | |
|-------------------|---------------|-------|
| | Day * | Night |
| Industrial | 75 | 70 |
| Commercial | 65 | 55 |
| Residential | 55 | 45 |
| Silence Zone ** | 50 | 40 |

Source: Central Pollution Control Board

* Day Time is from 6.00 AM to 9.00 PM.

** **Silence Zone** is defined as an area up to 100m around premises of Hospitals, Educational Institutions and Courts. Use of vehicle horn, loudspeaker and bursting of crackers is banned in these zones.

CHAPTER 2

PROJECT DESCRIPTION

2.1 EXISTING SYSTEMS

Mass transport needs of Mumbai Metropolitan Region (MMR) are met by Suburban Trains and Buses. MMR consists of Greater Mumbai, Thane and Raigad districts. The proposed Metro Rail project is in Greater Mumbai where vehicular traffic consists of two wheelers, auto rickshaw, cars, taxis, buses, commercial vehicles and others. Population and growth rate of vehicles in Greater Mumbai for the year 2005 and 2008 are depicted in **Table 2.1**.

TABLE 2.1
GROWTH RATE OF VEHICLE IN GREATER MUMBAI

| SL NO. | VEHICLES | NO. OF VEHICLES | | GROWTH RATE (%) |
|--------|---------------------|------------------|------------------|-----------------|
| | | 2005 | 2008 | |
| 1 | Two Wheelers | 647,892 | 865,466 | 11% |
| 2 | Auto Rickshaw | 104,104 | 108,812 | 2% |
| 3 | Car | 409,120 | 507,408 | 8% |
| 4 | Taxis | 58,049 | 58,813 | 0.4% |
| 5 | Buses | 12,290 | 13,239 | 3% |
| 6 | Commercial Vehicles | 56,345 | 71,329 | 9% |
| 7 | Others | 7,140 | 6,770 | -2% |
| | Total | 1,294,940 | 1,631,837 | 9% |

2.2 PROPOSED METRO SYSTEM IN MUMBAI

There is no existing metro system in Mumbai. Line I from Versova to Ghatkopar is under construction. Line II (Charkop-Bandra-Mankhurd) is finalised and construction will be started as the CRZ clearance will be accorded for Depot. As per the Mumbai Master Plan prepared by DMRC, **Table 2.2** depicts Mumbai Metro Corridors in three phases of execution which is shown in **Figure 2.1**. DPR studies for phase I metro corridors were carried out during the period 2005 -2009 (Line 1: Versova-Andheri-Ghatkopar, Line 2: Charkop-Bandra-Mankhurd and Line 3: Colaba -Bandra). In 2010, MMRDA also carried out the DPRs of four lines of Phase II & III.

TABLE 2.2
MUMBAI METRO MASTER PLAN

| LINE NO. | CORRIDOR | LENGTH (KM) | PHASE | IMPLEMENTATION |
|----------|-------------------------------|-------------|-------|----------------|
| 1 | Versova – Andheri – Ghatkopar | 15.0 | I | 2005-2011 |
| 2 | Charkop – Bandra - Mankhurd | 31.87 | | |
| 3 | Colaba - Bandra | 20.40 | | |
| 4 | Charkop – Dahisar (East) | 7.5 | II | 2011-2016 |

| | | | | |
|---|---------------------------------|---------------|-----|-----------|
| 5 | Ghatkopar – Mulund | 12.4 | | |
| 6 | BKC to Kanjurmarg via Airport | 19.5 | III | 2016-2021 |
| 7 | Andheri (East) – Dahisar (East) | 18.0 | | |
| 8 | Hutatma Chowk – Ghatkopar | 21.8 | | |
| 9 | Sewri – Prabhadevi | 3.5 | | |
| | | 149.97 | | |

Source: DPR, RITES (CTS for MMR, by LASA)

Phase wise length of metro corridor as per Master Plan and as per amendment is depicted in **Table 2.3**.

TABLE 2.3
LENGTH OF MUMBAI METRO PHASES

| S.No. | Phase | Length (km) as Master Plan | Length(Km) as per amendment |
|-------|--------------|----------------------------|-----------------------------|
| 1 | Phase I | 67.27 | 79.36 |
| 2 | Phase II | 19.90 | 19.90 |
| 3 | Phase III | 62.8 | 43.3 |
| | Total | 149.97 | 142.56 |

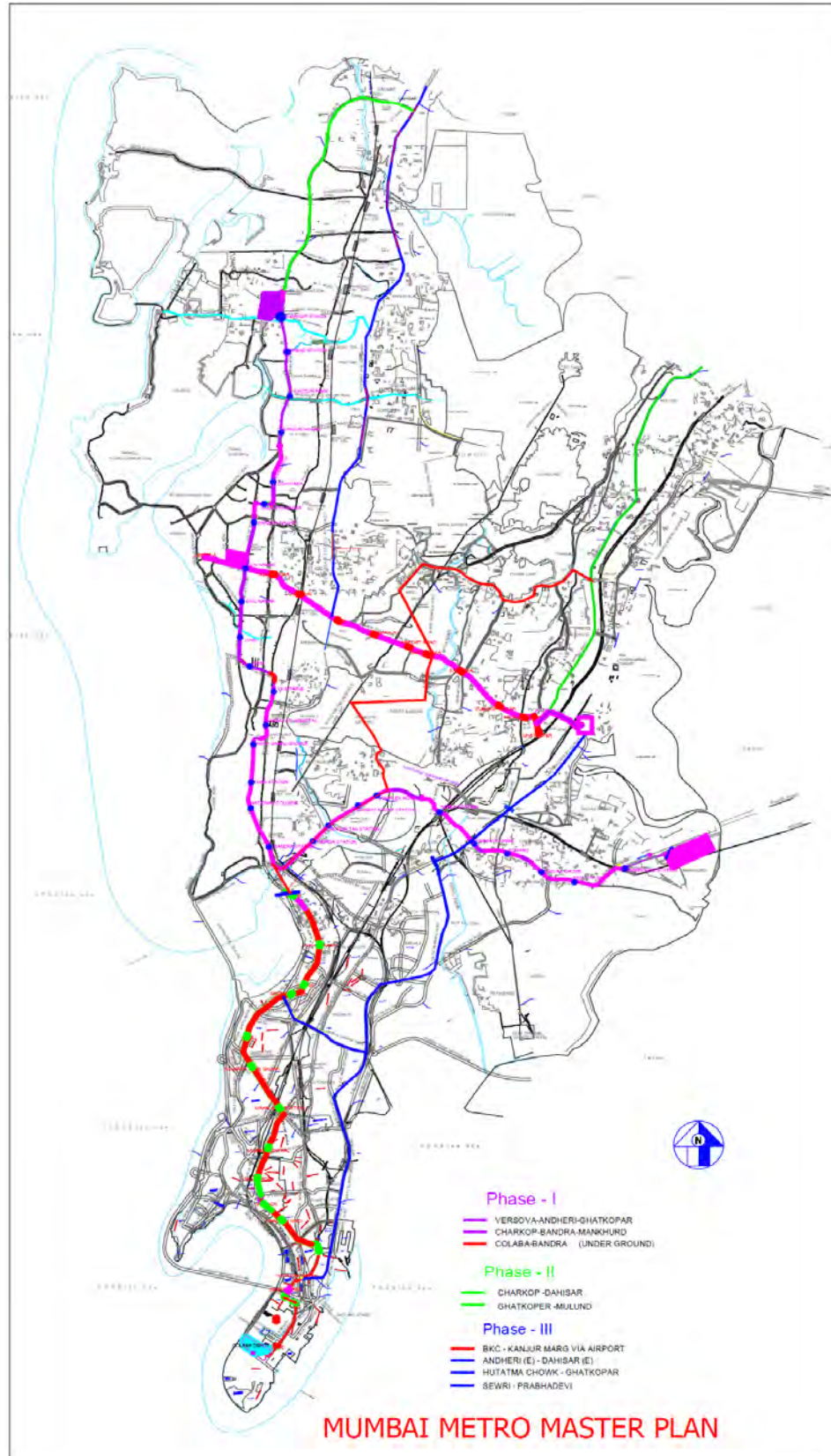
2.3 ANALYSIS OF ALTERNATIVES

2.3.1 Alignment Planning

Selection of an optional alignment is a multi-disciplinary decision, with objectives which may conflict with one another. The selection of approach for resolving the problem is the multi-criteria analysis for the alternative to be analyzed. The principal objectives which were considered while selecting the metro-alignment are minimization of the impact on the environment, optimization of the functionality of the alignment, minimization of construction time, minimization of construction and operational cost and maximization of the results of the economic investment. Minimization of construction time and construction and operational cost are amongst the criteria with the highest weighting factors in selecting the optimal alignment. While selecting the alignment of Mumbai Metro Rail corridors spread over in three phases and having total length of 149.87 km. Following parameters are taken into consideration:

- Catchment area,
- Integration with other mass transit corridors,
- Construction feasibility, and
- Environment and social aspects.

**FIGURE 2.1
MUMBAI METRO MASTER PLAN**



Detailed Project Report from Colaba to Bandra falling in Phase I was prepared by Delhi Metro Rail Corporation Ltd in 2007 and BKC to Kanjur Marg via Airport (Line VI) in Phase III was prepared by RITES Limited in 2011.

The present proposed alignment from Colaba to SEEPZ via BKC has been finalized by combining Line III and Line VI. Line III had been proposed underground from Colaba to Mahim and elevated from Mahim to Bandra. Line VI was underground from Mahim to ITO and elevated from ITO to Kanjur marg. Another alternative in this alignment was elevated from Mahim to ITO. Considering the environmental, social, traffic and land availability aspects, it was decided to keep the proposed alignment underground.

The National Facilitation Committee (NFC), in its meeting held on September 3, 2009, decided that the metro connectivity to the CSIA be expedited and put in the phase 1, rather than in the phase 3 as per Metro Master Plan. This was decided to be achieved by merging Line 6 of phase3, named BKC-Kanjur Marg via Airport with the Line 3 of phase I, i.e Colaba-Mahim-Bandra and run through services from Colaba till SEEPZ.

2.3.2 Proposed Alignment

The proposed alignment as mentioned in 2.4.1 was studied by RITES Ltd. During the study, RITES Ltd examined the proposed alignment to finalize it. Two alternatives were taken between Cuffe Parade Road and Vidhan Bhawan for analysis. These two alternatives were studied and their benefits and drawbacks were examined, which are depicted in subsequent para.

Alternative-I

From Cuffe Parade Road (fisherman colony), alignment takes left turn to cross the sea and follows the Jamnala Bajaj Road and passes in front of Vidhan Bhawan. The major disadvantage of the alignment is that the 600 m alignment was passing under sea.

Alternative-II

From Cuffe Parade Road, alignment follows Foreshore Road (Captain Prashant Pethe Marg) and takes left turn near Fire station and passes through State Govt. Barracks and between Vidhan Bhawan/SBI building. The merit of this alignment is that it is close to Mantralaya as well as Vidhan Bhawan. The major advantage is to serve the important catchment areas of Colaba localities. Also by selecting this alignment the route passing under sea in Alternative I is avoided.

Hence, MMRDA has decided to adopt Alternative II to serve additional catchment areas and avoid the sea route. The two alternatives are shown in **Figure 2.2**.

**FIGURE 2.2
ALTERNATIVE ROUTES**



2.4 Depot Planning

The proposed corridor would require a dedicated depot for the maintenance of the rakes. The inspection, overhauling and all maintenance facilities for P Way, S & T, OHE etc will also be provided at the depot cum maintenance workshop. As per the preliminary assessment, train operation on Colaba-Bandra-SEEPZ corridor will require about 45 rakes of 4 cars to meet the traffic projection in the horizon year 2031. Depot cum workshop shall have necessary facilities viz stabling lines, schedule inspection lines, workshop for overhaul, unscheduled maintenance including major repairs, wheel profiling, and heavy interior/under frame/roof cleaning etc.

In addition, the Depot will also house for operation control centre (OCC), administrative building, maintenance facilities for civil-track, water supply; electrical-traction, E&M; signalling & telecomm; etc.

2.4.1 Car Depot Site Requirement

The pre requisites of coach maintenance depot site are as under-

- A plot size of adequate area- about 30 Ha,
- Proximity to alignment: Site must be located as close to the alignment as possible.
- Ease to movement: There should not be any obstruction to movement of rakes in either direction

2.4.2 Proposed Alternative sites for Depot

Following sites had been selected for the depot having requisite size along the alignment.

- Mahalaxmi Race Course
- Kalina University land
- Aarey milk colony land

Alternative I: Mahalaxmi Race Course

The land requirement of 19.2 Ha is available and it is well close to alignment. The rakes are easily placed & retrieved from depot from Science Museum station. However, the land requirement for depot is in possession of Royal Western India Turf Club and the grandstand of the course is a designated heritage structure which requires additional clearance.

Alternative II: Kalina University land

Kalina University is located at the western edge of BKC with a total vacant area available of 20 Ha and it is well close to the alignment i.e less than 1 km. The rakes are easily placed & retrieved from depot in either direction. However, it would be difficult to acquire land as the land is in possession of Kalina University and is meant for educational purposes. Also the part of the land is falls in CRZ-II, hence additional clearance will be required.

Alternative III : Aarey Milk Colony

Aarey Milk Colony land is adequate in size for metro car depot located along JVLR opposite to SEEPZ. The proposed depot land is very close to the alignment. The depot can be constructed at-grade level. No major complications are involved in shifting of public utilities. Also rakes can be easily placed & retrieved from depot. Furthermore future expansion would be possible as adequate land is available in the vicinity. However, only the corridor needs to be expanded for about 1 km for the depot accessibility.

In view of the above, depot cum workshop is found to be more suitable at Aarey milk colony land. The area is also available for future expansion and the proper landscaping can be retained or enhanced the beauty of the area. The alignment is shown in the **Figure 2.3**.

2.5 MAJOR SECTION OF PROPOSED METRO CORRIDOR (LINE III)

The proposed Metro corridor will facilitate the commuters to travel from South Mumbai to Airport via Mahim-BKC. It will also provide direct access to the economic hubs such as BKC, MIDC Industrial Estate, SEEPZ and famous landmarks such as Kalina University, Mahalaxmi etc. The proposed 33.51 km metro corridor has been divided into six sections as depicted in **Table 2.4**.

TABLE 2.4
MAJOR SECTIONS OF METRO CORRIDOR (PHASE III)

| S.NO. | MAJOR SECTIONS | LENGTH IN KM |
|--------------|--------------------------------|---------------------|
| 1 | Colaba/WTC/Cuffe Parade to CST | 4.475 |
| 2 | CST to Science Museum | 7.000 |
| 3 | Science Museum to Mahim | 7.000 |
| 4 | Mahim to Airport | 7.000 |
| 5 | Airport Region | 5.000 |
| 6 | Airport to SEEPZ | 3.033 |
| | Total | 33.508 |

FIGURE 2.3
ALTERNATIVE DEPOT LOCATIONS



2.6 RIDERSHIP ON PROPOSED METRO CORRIDOR

The ridership has been estimated by MMRDA based on the results of CTS Transport Demand Model considering the following points.

1. P3E3 land use scenario is considered in which growth to MCGM and RoR is allocated in equal proportion.
2. CTS proposed Road and Rail network is considered for horizon years 2016, 2021 and 2031.
3. Metro Fare is considered as 1.5 times the ordinary bus fare.
4. Speed of the metro is taken as 35 kmph.
5. Frequency of metro service is considered as 4 minutes for 2016 and 3 minutes for 2025 and 2.5 minutes for 2031 horizon years.

Based on the above consideration, the proposed Metro Corridor is expected to have a daily ridership of 16.99 Lakh and Maximum PHPDT of 42000 by 2031. These are shown in **Table 2.5**

TABLE 2.5
MAXIMUM PHPDT AND DAILY RIDERSHIP

| YEAR | MAXIMUM PHPDT | DAILY RIDERSHIP (IN LAKH) |
|------|---------------|---------------------------|
| 2016 | 25700 | 10.06 |
| 2021 | 39000 | 13.87 |
| 2031 | 42000 | 16.99 |

The proposed corridor has two distinct sections in terms of passenger loading (i) Colaba- Bandra with higher peak section loads, and (ii) Bandra – SEEPZ with comparatively lower section loads. Hence a mid terminal facility is proposed at Bandra Metro station to enable differential train frequencies in these two sections. The broad PHPDT for the two sections are depicted in **Table 2.6**. These will be considered to work out the train operation plan, rake requirement etc.

TABLE 2.6
PHPDT FOR COLABA – BANDRA AND BANDRA - SEEPZ

| SECTION/YEAR | 2016 | 2021 | 2031 |
|---------------|-------|-------|-------|
| Colaba-Bandra | 25000 | 36000 | 40000 |
| Bandra-SEEPZ | 16000 | 18000 | 21000 |

2.7 ROLLING STOCK, TRACTION AND SIGNALLING

The salient features of proposed Metro Corridor (underground) in respect of rolling stock, power supply, traction system and signalling are summarised in DPR and reproduced below:

- A short train consisting of 4 cars with high frequency service which can be increased to 6-cars and 8-car for increasing the Passenger Carrying Capacity of Trains with the consideration of matching the growing traffic demand.
- The rolling stock shall be Standard 1435 mm track gauge Section having maximum width of 3.20 m, Axle load of 17 tonnes and capacity of 4 coach unit as 1178 passengers. Seating arrangement will be longitudinal and AC class accommodation will be provided.
- 25 KV AC 50 Hz Traction system is proposed to fulfil the power demand of 65 – 48 MVA in 2016. Three receiving stations have been proposed at Colaba (Cuffe Parade), Race Course and Dharavi.
- The system, under normal operating conditions, will be an automatically operated system utilizing Automatic Train Control and Automatic Train Protection (ATP) under the overall control of a train driver and OCC operators.
- Computer Based Interlocking (CBI) signalling and continuous automatic train control with Automatic Train Protection (ATP) is proposed., while telecommunication system is integrated with Optical Fiber Cable, LED/LCD based boards, Mobile Radio, Mobile system etc.
- Fare collection system is provided with automation in association with Contactless Smart Card and Retractable Flap Type Control Gates, Ticket Office Machine, TR, PTD etc.

2.8 PASSENGER CARRYING CAPACITY

In order to maximise the passenger carrying capacity, longitudinal seating arrangement shall be adopted. Criteria for the calculation of standing passengers are 3 persons per square metre of floor area in normal state, 6 persons in crush state of peak hour and 8 persons in dense crush state of peak hour. Therefore, Driving Trailer with 21.84 m car body length, 3.2 m car body width and longitudinal seat arrangement conceptually have the capacity of 43 seated, 239 standing, thus a total of 282 passengers while a Motor car with 21.74 m car body length, 3.2 m car body width and longitudinal seat arrangement conceptually have the capacity of 50 seated, 257 standing, thus a total of 307 passengers for a car is envisaged considering a standee area of 6 persons per square metre. These are shown in **Table 2.7**.

TABLE 2.7
CARRYING CAPACITY A CAR

| DESCRIPTION | DRIVING TRAILER CAR | | TRAILER CAR/ MOTOR CAR | | 4 CAR TRAIN | 6 CAR TRAIN | 8 CAR TRAIN |
|--------------|------------------------|------------|---------------------------|------------|----------------|----------------|----------------|
| | Normal | Crush | Normal | Crush | Crush | Crush | Crush |
| Seated | 43 | 43 | 50 | 50 | 186 | 286 | 386 |
| Standing | 120 | 239 | 129 | 257 | 992 | 1506 | 2020 |
| Total | 163 | 282 | 179 | 307 | 1178 | 1792 | 2406 |

2.9 MAINTENANCE DEPOTS

The maintenance depot along with full workshop facilities have been proposed at Arey Milk Colony for the proposed metro corridor. The facilities include for the maintenance of the Rakes, Track, Electrical – Traction (OHE), E & M, Signalling & Telecom, Automatic Fare Collection etc. It will house Operation Control Centre (OCC) and Administrative Building. All the systems at depot have been designed to cater for 55 rakes of 8 Car composition to take care of requirement beyond the horizon year 2031. In 2031, rake requirement is 55 with 6 coaches.

2.10 POWER REQUIREMENTS

Power supply is required for the operation of Metro system for running of trains, station services, workshop, depot and other maintenance works within the premises of metro system. The power requirement is for peak hour demand for traction and auxiliary application. The power requirement is estimated on the basis of 8 car train operation at 150 second headway for Colaba-Bandra section and 300 second headway for Bandra-SEEPZ section considering requirement beyond the horizon year 2031. Some of assumptions to estimate the power supply are

- Specific energy consumption of rolling stock : 70 KWh per 1000 GTKM
- Train operation design :150 seconds headway on Colaba-Bandra and 300 seconds headway on Bandra-SEEPZ section
- Underground station : Design Load 3000 kW
- Depot auxiliary : Design load 3000 kW
- Power factor of load : 0.9 and Transmission losses @ 5%

Keeping in view the above norms, designed load and power requirement projected are depicted in **Table 2.8**

TABLE 2.8
POWER DEMAND IN MVA

| PARTICULARS/YEAR | 2016 | 2021 | 2031 | TOTAL |
|------------------|-------|--------|--------|--------|
| Traction | 24.13 | 32.49 | 37.71 | 55.88 |
| Auxiliary | 65.33 | 73.50 | 81.67 | 98.00 |
| Total | 89.46 | 105.99 | 119.38 | 153.88 |

2.11 SUB STATIONS

As per power supply network of Mumbai city, the city has 220 KV, 100 kV, 33/22 kV and 11 kV network to cater to various types of demand in the vicinity of proposed corridor. Out of these, 33 kV and 100 kV networks are highly reliable and stable to meet the power requirement of 33 kV and 25 kV for the proposed corridor as per the discussion with Tata Power Company Limited. Keeping in view the reliability requirements and considering the complete corridor of 33.508 m length with all underground stations, three receiving Sub-stations are proposed to avail power supply for traction as well as auxilliary services from three grid sub-stations at 100 kV voltage through cable feeders for Colaba-Bandra-SEEPZ Corridor. Sources of Power Supply are depicted as in **Table 2.9**

**TABLE 2.9
SOURCES OF POWER SUPPLY**

| S NO. | GRID SUB-STATION | RECEIVING SUB-STATION | CABLES |
|-------|-----------------------|----------------------------|-----------------------------------|
| 1 | Badhwar Park (100 kV) | Colaba (100/33/25 kV) | 2 km 100 kV double circuit cables |
| 2 | Mahalaxmi (100 kV) | Race Course (100/33/25 kV) | 1 km 100 kV double circuit cables |
| 3 | Dharavi (100 kV) | Dharavi (100/33/25 kV) | 1 km 100 kV double circuit cables |

2.12 CONSTRUCTION METHODOLOGY

Construction of the underground section shall be done by Cut and Cover, NATM and Tunnel Boring Machine (TBM). Station will be constructed either by Cut and Cover or NATM method depending upon the availability of space.

2.12.1 Construction Strategy

Design and build contracts will be adopted for proposed corridor. There will be three major contracts 1. Civil Works, 2. System Contract and 3 Depot Contract. Under civil contact, Architectural finishes, fire fighting and general electrification will be included along with the civil construction works. System contract will be on the basis of design, construct and installation which will include Traction and Power Supply, Signal and Telecommunication, Lifts, Escalators, Fare collection, Rolling Stock, Track and Signages. Layout, design and construction and general electrification comes under the Depot contract.

2.12.2 Construction Period

It is proposed to complete the project in a time period of 60 months.

2.13 COST ESTIMATES

The project cost inclusive of private land and taxes is Rs 19753.00 Crores whereas total completion cost with all taxes, IDC, escalation & private land comes to Rs 24340.00 Crores. Bifurcation of cost is briefly described in **Table 2.10**.

**TABLE 2.10
PROJECT COST**

| S NO. | PARTICULARS | AMOUNT IN Rs CRORES |
|--------------|---|----------------------------|
| 1 | Total Construction Cost excluding Pvt land | 16368.00 |
| 2 | Pvt. Land cost | 1586.00 |
| 3 | Taxes | 2855.00 |
| | Total Cost inclusive of pvt land & Taxes | 19753.00 |
| | Total completion cost with all taxes, IDC, escalation & private land | 24340.00 |

CHAPTER-3 ENVIRONMENTAL BASELINE DATA

3.1 ENVIRONMENTAL SCOPING

This chapter describes the existing environmental settings in the study area. The objective of Environmental Impact Assessment (EIA) is to ascertain the baseline environmental conditions and then assess the impacts as a result of the proposed project during various phases of the project cycle. Identification of environmental parameters, data collection and impact predictions form the core of Environmental Impact Assessment process. Data on land environment has been collected and compiled from various published sources and field focused surveys. Attributes of the physical environment like air, water, soil, and noise quality in the surrounding area were assessed, primarily through field studies, and by undertaking monitoring and analysis of samples collected from field. Information about geology, hydrology, prevailing natural hazards like earthquakes, etc have been collected from literature reviews and authenticated information made available by government departments. Climatological data was collected from Indian Meteorological Department. The methodology adopted for data collection is highlighted wherever necessary. A scoping matrix along with the frequency adopted for data collection for environmental attributes is summarized in **Table 3.1**.

**TABLE 3.1
ENVIRONMENTAL ATTRIBUTES AND FREQUENCY OF MONITORING**

| S. NO | ATTRIBUTE | PARAMETER | FREQUENCY | SOURCE |
|-----------------------------------|------------------------|--|------------|---|
| LAND ENVIRONMENT | | | | |
| 1 | Soil | Soil Characteristics | Once | Field studies and Detailed project report |
| 2 | Geology | Geological Status | --- | Literature review |
| 3 | Seismology | Seismic Hazard | --- | Literature review |
| WATER ENVIRONMENT | | | | |
| 4 | Water Quality | Physical, Chemical and Biological parameters | One Season | Field studies/literature review |
| AIR, NOISE AND METEOROLOGY | | | | |
| 5 | Ambient Air Quality | PM2.5 , PM10, SO ₂ , NO _x , CO, HC | Two Season | Field Studies/literature review |
| 6 | Meteorology | Temperature, Relative humidity, Rainfall, wind direction and speed | Data | India Meteorological Department/literature review |
| 7 | Noise | Noise levels in dB (A) | One Season | Field monitoring |
| 8 | Vibration | | -- | Field monitoring & modeling |
| SCIO-ECONOMIC | | | | |
| 9 | Socio-economic aspects | Socio-economic characteristics | Once | Field Studies, Literature review. |
| Ecology | | | | |
| 10 | Trees | Number/species | Once | Filed Studies |

3.2 LAND ENVIRONMENT

The Project area is situated in Mumbai, the commercial capital of India. The average elevation of Mumbai plains is 14 m above the sea level (a-MSL). Mumbai is located along western Arabian coast of India from 18° 53' north to 19° 16' north latitude and from 72° East to 72° 59' longitude. Parameters involved in land environment are, physiography, geology and soils, and seismicity. These are discussed in the following paragraphs.

3.2.1 Physiography

The physiographic feature of the Mumbai district is broad and flat terrain flanked by north – south trending hill ranges. The hill ranges from almost parallel ridges in the eastern and western part of the area. The Powai – Kanheri hill ranges are the other hill extending in the eastern and central part running NNE – SSW. The maximum elevation of the area is 450 m above mean sea level (amsl) at some of the peaks of hill ranges. Trombay Island has north – south running hills with maximum elevation of 300 m above mean sea level (amsl). Malbar, Colaba, Worli and Pali hills are the isolated small ridges trending north – south in the western part of the district. The Powai – Kanheri hills form the largest hilly terrain in the central part of the Salsette Island and are the feeder zone for the three lakes viz., Powai, Vihar and Tulsi. There are a number of creeks, dissecting the area. Among them, Thane is the longest creek. Other major creeks are Manori, Malad and Mahim which protrudes in the main land and give rise to mud flangs and swamps. The area is drained by Mahim, Mithi, Dahisar and Polsar rivers. These small rivers near the coast, form small rivulets which intermingle with each other resulting in swamps and mud flats in the low lying areas

3.2.2 Geology and Soils

The entire Greater Mumbai area is occupied by Deccan basalt flows and the associated pyroclastics and the plutonic rocks of upper cretaceous to palaeogene age. The Deccan basalt of Mumbai Island is considered to be the youngest basalt of Eocene age. Overall the geology around Mumbai indicates presence of ultrabasic, basic and acid differentiates with intertrappean beds, agglomerates and tuffs. The ultrabasic differentiates are of limited occurrence. Acid rocks include rhyolite and quartz trachyte. The agglomerate and tuff include reworked material as indicated by current bedding and graded bedding. The basalt flows of the area have been grouped into compound flows (i.e pahoehoe type), simple flows and flows which do not fall in the above categories and hence termed as unclassified flows. The basaltic flows are typically of quartz and hypersthene normative with minor amount of olivine theolites. The lava of Mumbai is intern intruded by columnar jointed medium grained doleritic dykes.

The Deccan Trap basalt has been classified as Sahyadri Group which has been divided into three formations viz. the lower most Upper Ratangarh Formation followed by Elephanta Formation and topmost Borivali Formation. The Upper Ratangarh Formation is restricted to two patches, one from Kurla to Mulund and the other at SE of Kurla. The middle formation i.e Elephanta Formation comprising of simple and compound flows occur as small isolated patches in the SE corner of the city near Thane creek and covers very negligible area. The rest of the area is covered by rocks of Borivali Formation where it is not occupied by alluvium. Normally, alluvium is restricted to the western half of the

area. Laterite occurs as small isolated patches in the area north and east of Mulund. Bauxite occurs within the Laterite in a irregular shape and is not of any economic importance. The Geological features of the Mumbai are shown in the **Figure 3.1**.

The predominant soil cover in Mumbai city is sandy whereas in the suburban district, the soil cover is alluvial and loamy.

In order to ascertain the quality and nature of soil within the vicinity of the project site, six soil samples were collected. The location of soil samples is shown in the **Figure 3.2**. These samples were collected about 60 cm depth. The samples were tested for physical and chemical properties. The results of soil analysis are presented in **Table 3.2**. As per the test results it is observed that soil is tending to become alkaline. Soil has medium content of nitrogen, phosphors and potassium. At all places the soil texture is sandy silt.

TABLE 3.2
SOIL TEST RESULTS

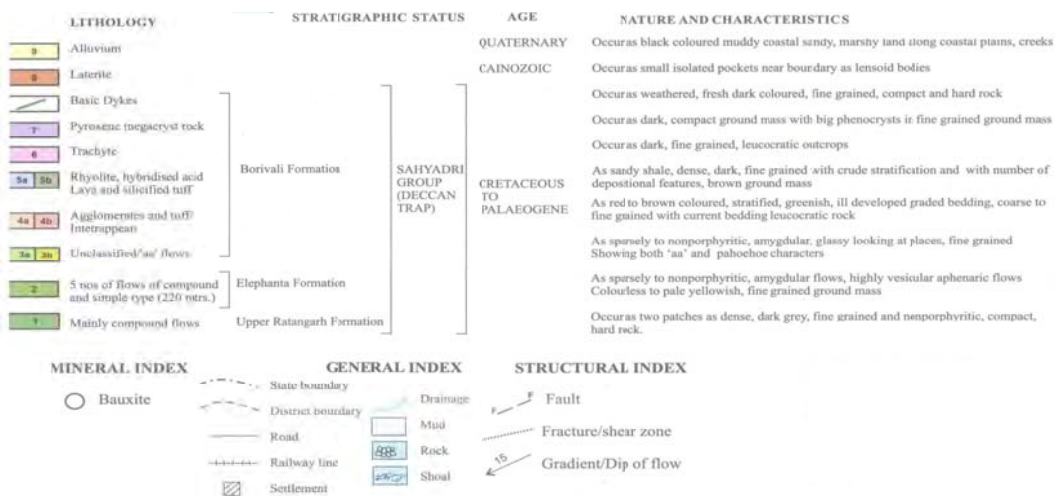
| S. NO | PARAMETER | LOCATION | | | | | |
|-------|---|--------------|--------------|--------|-----------------------|--------|--------------|
| | | Caffe Parade | Jacob Circle | Worli | International Airport | SEEPZ | Aarey Colony |
| 1. | pH | 7.10 | 7.60 | 7.87 | 7.19 | 6.80 | 6.28 |
| 2. | Conductivity (mS/cm) | 0.80 | 0.85 | 0.53 | 1.46 | 0.19 | 0.18 |
| 3. | Sodium (As Na, mg/100gm) | 22.61 | 21.02 | 35.59 | 18.34 | 7.62 | 3.45 |
| 4. | Organic Matter (% By Mass) | 1.80 | 1.48 | 1.37 | 0.90 | 1.15 | 1.53 |
| 5. | Nitrogen (N, Kg/hectare) | 121.99 | 33.77 | 28.81 | 40.09 | 32.72 | 41.57 |
| 6. | Calcium (As Ca, mg/100gm) | 329.94 | 648.09 | 710.94 | 487.05 | 263.16 | 141.40 |
| 7. | Chloride (As Cl, mg/100gm) | 450.63 | 404.54 | 289.29 | 262.86 | 299.22 | 208.55 |
| 8. | Magnesium (As Mg, mg/100gm) | 85.80 | 81.03 | 126.32 | 162.07 | 135.85 | 102.48 |
| 9. | Sand (% By Mass) | 46.20 | 42.30 | 40.20 | 39.50 | 39.30 | 64.12 |
| 10. | Silt (% By Mass) | 35.10 | 32.10 | 30.10 | 28.10 | 28.10 | 25.83 |
| 11. | Clay (% By Mass) | 11.10 | 10.20 | 10.10 | 11.40 | 11.20 | 10.10 |
| 12. | Potassium (As K, mg/100gm) | 179.98 | 366.80 | 232.06 | 130.59 | 51.95 | 94.43 |
| 13. | Phosphate (As Po ₄ , kg/hectare) | 23.68 | 16.24 | 24.27 | 14.87 | 30.80 | 13.01 |

3.2.3 Seismicity

The country has been classified into different zones indicating the intensity of damage or frequency of earthquake occurrences. These zoning maps indicate broadly the seismic coefficient that could generally be adopted for design of buildings in different parts of the country.

Mumbai lies in the Bureau of Indian Standards (BIS) in Seismic Zone III, which means the city is at moderate risk. The last time Mumbai witnessed seismic activity was in 2005. Three consecutive tremors of 4-5 magnitude were witnessed. Mumbai lies over more than 10 seismic fault lines. Major fault lines lie along the Thane creek, Ulhas river, the Manori and Malad creeks and the lakes. To the west, a fault line stretches from Colaba to Vasai, touching Malabar hill. The seismic zoning map of India showing Mumbai region is given in the **Figure 3.3**.

FIGURE 3.1
GEOLOGICAL MAP OF MUMBAI



**FIGURE 3.2
ENVIRONMENTAL MONITORING LOCATIONS**

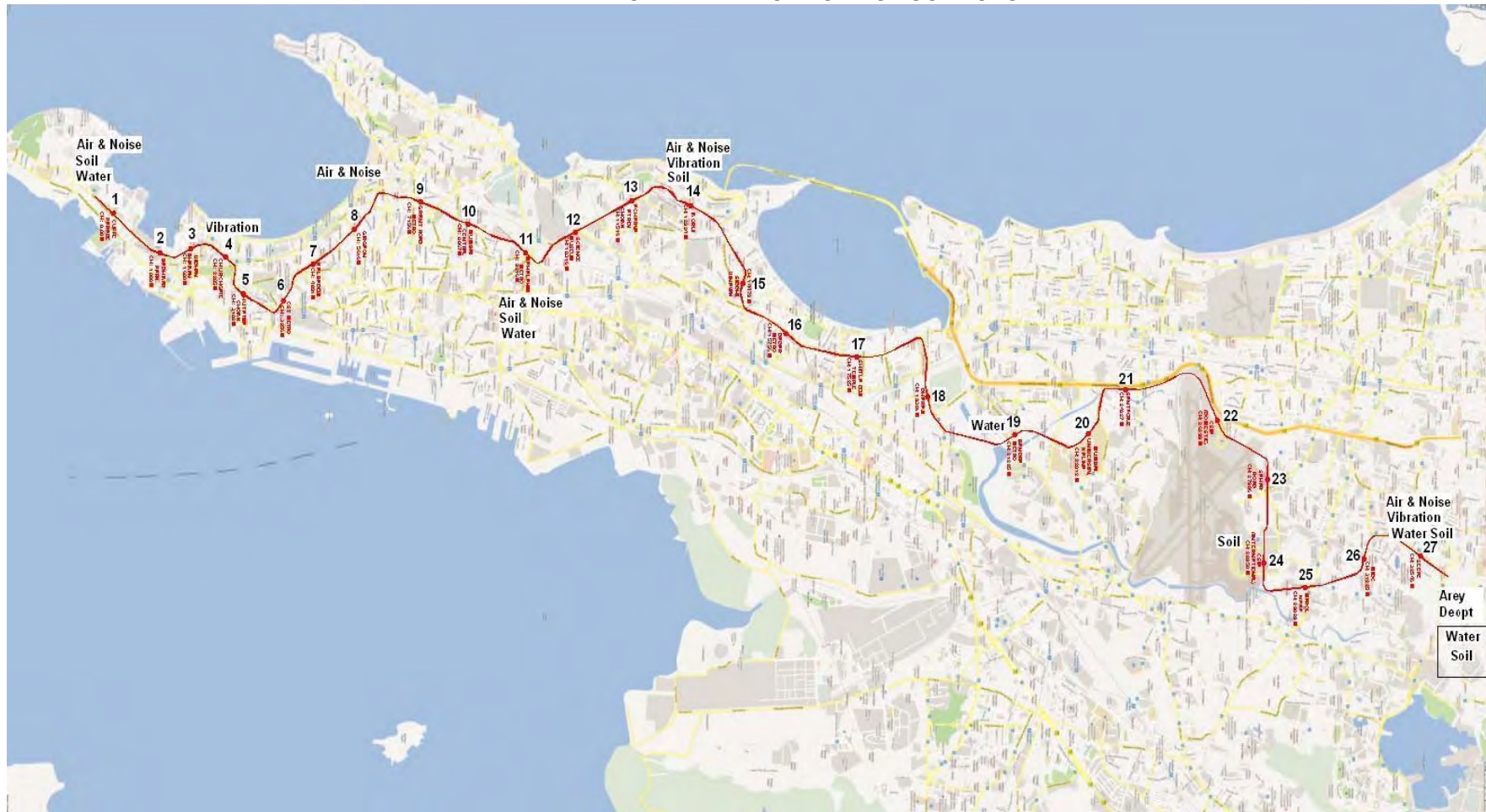
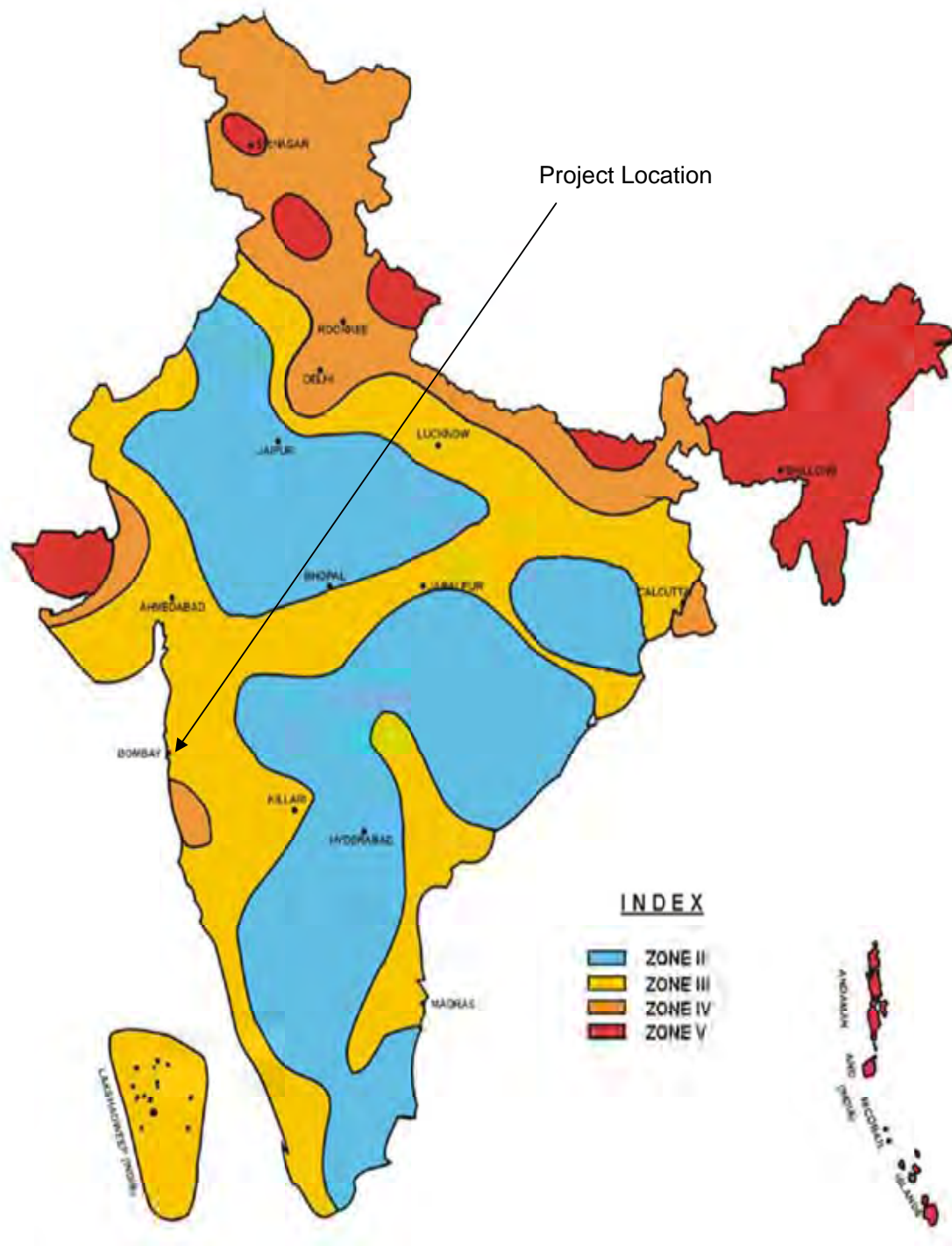


FIGURE 3.3
SEISMIC ZONING MAP OF INDIA



3.3 WATER ENVIRONMENT

Water environment consists of water resources and its quality. Its study is important from the point of view to assess the sufficiency of water resources for the needs of the project in its various stages of the project cycle and also to assess the impact of the project on water environment. Anticipated impacts of the proposed project on water environment have also been addressed.

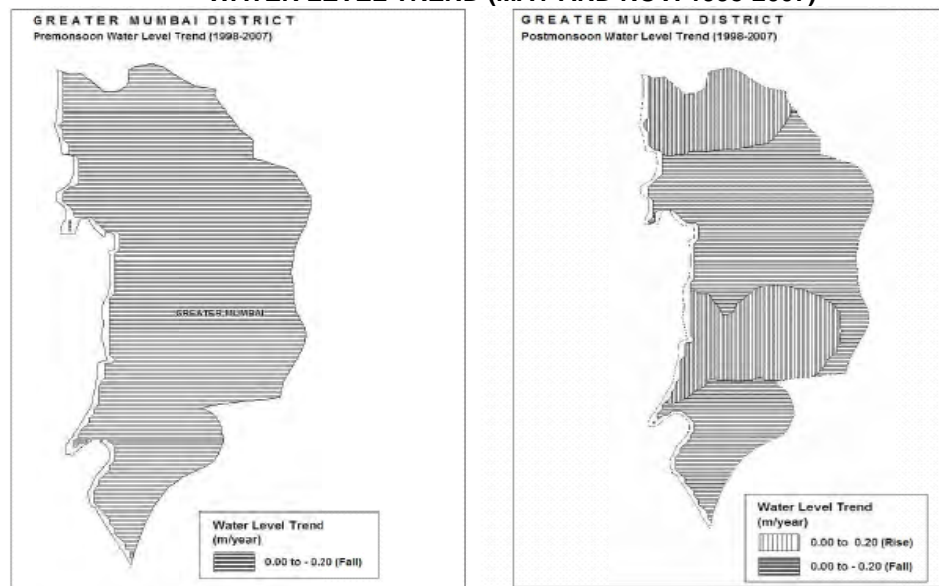
3.3.1 Water Resources

Water supply to Mumbai district are from various sources viz. Tulsi Lake (18 MLD), Vihar (110 MLD), Tansa (477 MLD), Vaitarna (1070 MLD) and Bhatsa (1475 MLD). The Central Ground Water Board, Ministry of Water Resources, Government of India monitored ground water depth in May 2007 which is reported in subsequent section.

3.3.2 Ground Water

As per the analysis and monitoring done by Central Ground Water Board (CGWB) during the year 1998 to 2007, decline in ground water levels has been observed in major parts of the district. The pre-monsoon and post monsoon trend maps were also prepared by CGWB and the same are presented in **Figure-3.4**. During pre-monsoon period entire district shows fall in water level trend of up to 20 cm/year, whereas during post-monsoon period rise in water level trend of up to 20 cm/year is observed in extreme northern part and central southern parts and the rest of the district shows fall in water level trend of up to 20 cm/year.

FIGURE-3.4
WATER LEVEL TREND (MAY AND NOV. 1998-2007)



The pre-monsoon depth to water levels ranges between 2.77 m bgl (Church Gate) and 6.42 m bgl (A.M.C. Colony). The depth to water levels during pre-monsoon has been depicted in **Figure-3.5**. The shallow water levels between 2 and 5 m bgl are observed in southern part, whereas moderate water levels in the range of 5 to 10m bgl are observed in northern part of the area.

The depth to water levels during post-monsoon ranges between 1.80 m bgl (Church Gate) and 7.10 m bgl (A.M.C. Colony). Spatial variation in post-monsoon depth to water level is shown in **Figure-3.6**. The water levels in major part of the district range between 2 and 5 m bgl. Shallow water levels of < 2 m bgl are observed in small area in southern part, whereas water levels of 5 to 10 m bgl are observed in north central part of the district.

FIGURE-3.5
DEPTH TO WATER LEVEL (PRE-MONSOON)

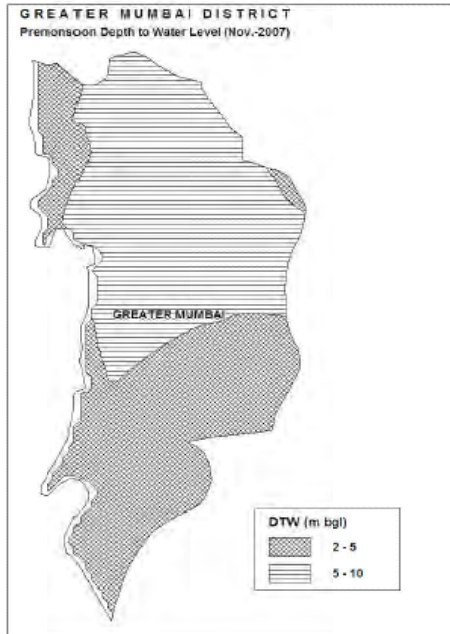
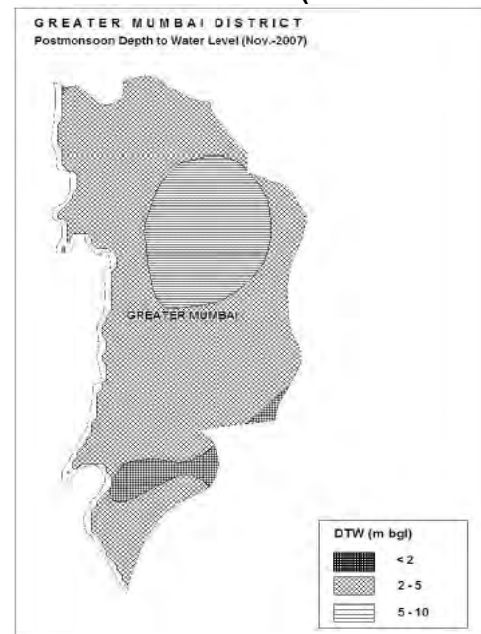


FIGURE-3.6
DEPTH TO WATER LEVEL (POST-MONSOON)



3.3.3 Water Quality

Water quality is the physical, chemical and biological characteristics of water. It is most frequently used with reference to a set of standards against which compliance can be assessed. The most common standards used to assess water quality relate to drinking water, safety of human contact, and for health of ecosystems. An understanding of the various factors influencing water quality is thus very important as human health is largely dependent on the quality of water available for our use.

Central Ground Water Board monitors the ground water quality of the district through analysis of water samples collected by keeping objective to understand an overall picture of ground water quality of the district during year 2007. The result of chemical analysis shows that the ground water in the district is alkaline in nature. The concentration of

major ions indicates that among the cations, the concentration of sodium and magnesium ion is almost same followed by calcium, while among the anions the concentration of bicarbonate ion is highest, followed by chloride, sulphate and nitrate ions. The suitability of ground water for drinking were checked with the standards proposed by the Bureau of Indian Standards (BIS) (IS-10500-91, Revised 2003). The concentrations of all the parameters in all the samples tested were within the Maximum Permissible Limit (MPL). Therefore, it can be concluded that the ground water quality in majority of the area were good for drinking purpose.

In order to collect baseline data on the existing water quality, water samples were collected from 5 different locations along the alignment in the project study area and analyzed as per the procedure specified in standard methods for examination of water and wastewater published by American Public Health Association and the Bureau of Indian Standards (APHA/BIS). The results of the physio-chemical analysis are summarized in the **Table 3.3**.

The test results when compared with the prescribed limits of various parameters as per IS 10500:1991 indicated that at some locations certain parameters are more than desirable limit. These values are shown in bold italics in the table. Most of the parameters tested for Mahim Creek (Location 3) are more than permissible limit. At rest of the locations, the parameters are within limit as per IS 10500:1991.

TABLE 3.3
WATER QUALITY AT PROJECT SITE

| PARAMETER | LOCATION | | | | | | | |
|--|----------|--------|---------|--------|--------|--------|--------|--------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| pH | 7.20 | 7.21 | 6.89 | 7.10 | 7.02 | 6.98 | 7.41 | 7.72 |
| Total Hardness as CaCO ₃ (Mg/l) | 48.0 | 60.00 | 3500 | 140.00 | 44.00 | 444.72 | 126.48 | 379.44 |
| Calcium (As Ca, mg/l) | 8.02 | 11.22 | 480.96 | 38.48 | 9.62 | 107.93 | 31.07 | 55.60 |
| Alkalinity (As CaCO ₃ , Mg/l) | 51.08 | 52.39 | 2060.19 | 143.91 | 80.15 | 466.44 | 102.29 | 249.23 |
| Chloride (As Cl, mg/l) | 13.80 | 9.86 | 5518.86 | 25.62 | 11.83 | 181.99 | 58.71 | 68.49 |
| Magnesium (As Mg, mg/l) | 6.80 | 7.78 | 558.90 | 10.69 | 4.86 | 42.63 | 11.90 | 58.49 |
| Total Dissolved Solid (mg/l) | 123 | 155 | 15387.0 | 278.00 | 181.00 | 949.00 | 261.00 | 567.0 |
| Sulphate (As SO ₄ , mg/l) | 3.13 | 4.17 | 615.13 | 10.71 | 4.17 | 11.49 | 4.90 | 36.79 |
| Fluoride (As F, mg/l) | 0.11 | 0.21 | 3.11 | 0.36 | 0.27 | 0.47 | 0.15 | 0.41 |
| Nitrate (NO ₃ , mg/l) | 0.11 | 0.42 | 0.34 | 0.02 | 0.46 | 0.34 | 0.29 | 0.19 |
| Iron (As Fe, mg/l) | 0.05 | 0.08 | 0.32 | 0.08 | 0.06 | 0.13 | 0.07 | 0.07 |
| Aluminium (As Al, Mg/l) | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 | <0.03 |
| Phenolic Compounds (Mg/l) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Zinc (As Zn, mg/l) | <0.10 | <0.10 | 0.17 | <0.10 | <0.10 | <0.10 | <0.10 | <0.10 |
| Chromium (As Cr, Mg/l) | <0.01 | <0.01 | 0.01 | <0.01 | <0.001 | <0.01 | <0.01 | <0.01 |
| Copper (As Cu, mg/l) | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Manganese (As Mn, Mg/l) | <0.10 | <0.10 | 0.10 | <10.0 | <0.10 | <0.10 | <0.10 | <0.10 |
| Cadmium (as Cd, mg/l) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Lead (As Pb, mg/l) | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Arsenic (As As, Mg/l) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | <0.05 | <0.05 | <0.05 |
| Mercury (as Hg, mg/l) | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Sodium (As Na, Mg/l) | 16.00 | 50.00 | 3475.00 | 58.00 | 48.30 | 110.00 | 12.00 | 48.0 |
| Potassium (As K, Mg/l) | 0.20 | 2.00 | 120.00 | 14.00 | 0.30 | 104.00 | 2.00 | 15.0 |
| Phosphate (as PO ₄ , mg/l) | <0.02 | <0.02 | 1.39 | 0.01 | <0.02 | <0.02 | 0.02 | 0.07 |

| | | | | | | | | |
|--|-------|-------|--------|-------|-------|-------|-------|-------|
| Total Suspended Solids (Mg/l) | <5.0 | <5.0 | 187.00 | 8.40 | <5.0 | 21.00 | 27.00 | <5.0 |
| Biochemical Oxygen Demand at 20°C for 3 Days | <1.0 | <1.0 | 144.00 | <1.0 | <1.0 | 14.40 | 15.60 | <1.0 |
| Chemical Oxygen Demand (mg/l) | <5.0 | <5.0 | 380.00 | <5.0 | <5.0 | 54.76 | 39.82 | <5.0 |
| Oil & Grease (mg) | <0.40 | <0.40 | 0.60 | <0.40 | <0.40 | <0.40 | 0.40 | <0.20 |
| Dissolved Oxygen (mg/l) | 5.08 | 5.17 | 4.08 | 5.27 | 5.07 | 4.88 | 3.51 | 5.56 |
| Nickel (as Ni, mg/l) | <0.20 | <0.20 | <0.20 | <0.2 | <0.20 | <0.20 | <0.20 | <0.20 |
| Total Coliform (MPN/100 ml) | <2.0 | <2.0 | 78.00 | <2.0 | <2.0 | 39.00 | 500.0 | <2.0 |

Source: Sampling as per IS: 10500, 1991 – Drinking Water Specifications

Sampling Locations: 1. Caffe Parade (Ground water), 2. Jacob Circle (Tap Water), 3. Mahim Creek (Surface water), 4. Aarey Colony (Ground Water), 5. SEEPZ (Tap Water), 6. Andheri East, (Handpump) 7. Mithi River (Surface water), 8. Parsi Well, Charchgate (Well water).

3.4 METEOROLOGY AND AIR ENVIRONMENT

Meteorology is an important parameter in an environmental impact assessment study. All air pollutants emitted by point and non-point sources are transported, dispersed or concentrated by meteorological and topographical conditions. The main parameters are: temperature, humidity, rainfall, winds and cloud cover. The meteorological data of Mumbai is collected from Regional Meteorological Centre (RMC), India Meteorological Department (IMD) for the year 2009 to year 2011. The data has been collected at Colaba and Santacruz station. The meteorology and air environment of the area are discussed in subsequent sections.

3.4.1 Meteorology

Mumbai experiences tropical savanna climate. The climatic conditions in project area are experienced four distinct seasons monsoon (June-September), post monsoon (October-December), winter (December-February) and summer (March-May).

The normal annual rainfall over the district varies from about 1800 mm to about 2400 mm. It is minimum in the central part of the district around Kurla (1804.9 mm). It gradually increases towards north and reaches a maximum around Santacruz (2382.0 mm). The relative humidity at Mumbai ranges between 54.5 % to 85.5%. Records of monthly total rainfall, mean maximum and mean minimum relative humidity of Mumbai obtained from Regional Meteorological Department (RMC), Colaba and Santacruz has been presented in **Table 3.4** to **Table 3.6**.

The mean minimum temperature is 16.3°C and the mean maximum temperature is 32.2°C at Santacruz. Records of mean maximum and mean minimum temperatures are given in **Table 3.7** and **Table 3.8** respectively.

The predominant wind direction is south/south-west in monsoon and north/north-east in winter. The windrose diagrams showing wind speed and direction at 8:30 and 17:30 hrs are prepared and placed at **Figure 3.7**.

TABLE 3.4
MONTHLY TOTAL RAINFALL AT STATION: COLABA

| PARAMETERS | YEAR | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC |
|------------------------------------|------|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|
| MONTHLY TOTAL RAINFALL (MM) | 2009 | 0.000 | 0.000 | trace | 0.000 | 002.3 | 265.9 | 771.3 | 204.5 | 519.1 | 158.3 | 120.2 | trace |
| | 2010 | trace | trace | 000.0 | 000.3 | 000.0 | 947.4 | 1099.0 | 849.8 | 272.9 | 122.4 | 053.7 | 000.0 |
| | 2011 | 000.0 | 000.1 | 000.0 | 000.0 | 000.7 | 461.2 | | | | | | |

TABLE 3.5
MONTHLY TOTAL RAINFALL AT STATION: SANTACRUZ

| PARAMETERS | YEAR | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC |
|------------------------------------|------|-------|-------|-------|-------|-------|-------|--------|--------|-------|-------|-------|-------|
| MONTHLY TOTAL RAINFALL (MM) | 2009 | 000.0 | 000.0 | 000.0 | 000.0 | 000.3 | 216.4 | 1142.2 | 290.3 | 322.2 | 223.3 | 77.5 | trace |
| | 2010 | 000.0 | trace | 000.0 | 000.7 | 000.0 | 712.1 | 1250.4 | 1036.5 | 328.9 | 064.0 | 047.2 | 000.0 |
| | 2011 | 000.0 | 000.0 | 000.0 | 000.0 | trace | 661.7 | -- | -- | -- | -- | -- | -- |

TABLE 3.6
MONTHLY MEAN RELATIVE HUMIDITY AT STATION: COLABA

| PARAMETERS | YEAR | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC |
|--|------|-----|-----|-----|-----|-----|------|------|-----|------|-----|-----|-----|
| MONTHLY MEAN RELATIVE HUMIDITY AT 08:30 HRS (%) | 2009 | 81 | 86 | 79 | 79 | 79 | 85 | 93 | 91 | 92 | 86 | 85 | 84 |
| | 2010 | 80 | 85 | 88 | 83 | 84 | 92 | 96 | 96 | 90 | 85 | 86 | 78 |
| | 2011 | 80 | 85 | 81 | 83 | 77 | 92 | -- | -- | -- | -- | -- | -- |
| MONTHLY MEAN RELATIVE HUMIDITY AT 17:30 HRS (%) | 2009 | 61 | 64 | 63 | 67 | 67 | 75 | 88 | 81 | 83 | 76 | 72 | 64 |
| | 2010 | 63 | 62 | 70 | 74 | 72 | 84 | 91 | 90 | 82 | 72 | 73 | 59 |
| | 2011 | 63 | 62 | 58 | 74 | 68 | 84 | -- | -- | -- | -- | -- | -- |

TABLE 3.7
MONTHLY MEAN RELATIVE HUMIDITY AT STATION: SANTACRUZ

| PARAMETERS | YEAR | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC |
|--|------|-----|-----|-----|-----|-----|------|------|-----|------|-----|-----|-----|
| MONTHLY MEAN RELATIVE HUMIDITY AT 08:30 HRS (%) | 2009 | 78 | 77 | 73 | 70 | 69 | 74 | 88 | 84 | 87 | 79 | 77 | 75 |
| | 2010 | 65 | 76 | 79 | 69 | 71 | 83 | 91 | 90 | 86 | 84 | 79 | 77 |
| | 2011 | 77 | 77 | 72 | 77 | 71 | 78 | -- | -- | -- | -- | -- | -- |
| MONTHLY MEAN RELATIVE HUMIDITY AT 17:30 HRS (%) | 2009 | 49 | 44 | 49 | 56 | 63 | 68 | 84 | 77 | 77 | 64 | 61 | 55 |
| | 2010 | 47 | 52 | 54 | 61 | 66 | 75 | 84 | 83 | 75 | 68 | 69 | 57 |
| | 2011 | 45 | 46 | 45 | 65 | 65 | 79 | -- | -- | -- | -- | -- | -- |

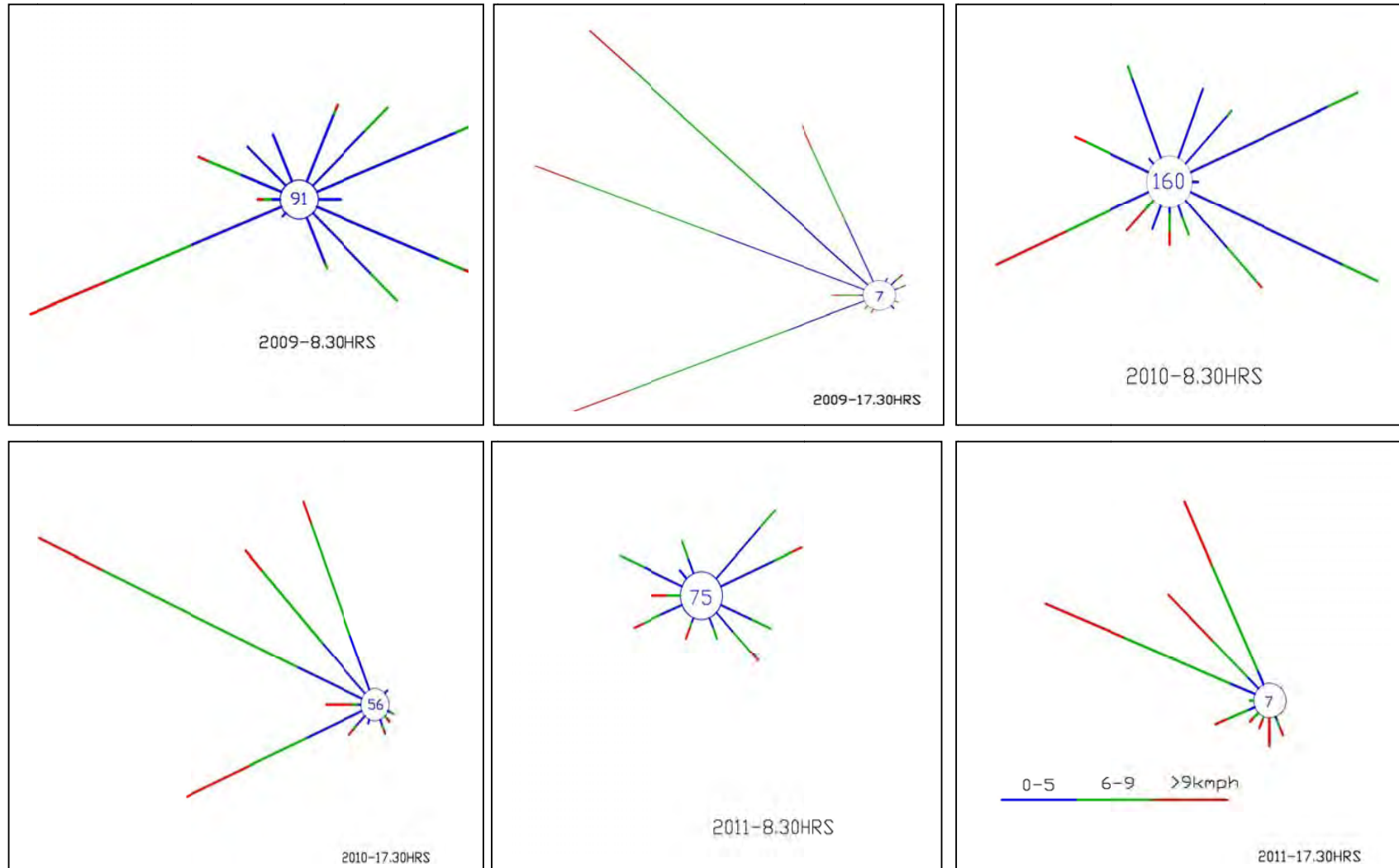
TABLE 3.8
MONTHLY MEAN MAXIMUM AND MINIMUM TEMPERATURE AT STATION: COLABA

| PARAMETERS | YEAR | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC |
|---|------|------|------|------|------|------|------|------|------|------|------|------|------|
| MONTHLY MEAN MAXIMUM TEMPERATURE (deg C) | 2009 | 32.0 | 30.7 | 32.6 | 34.2 | 34.7 | 33.8 | 29.5 | 31.2 | 31.1 | 32.7 | 32.8 | 32.2 |
| | 2010 | 32.0 | 30.4 | 32.1 | 34.3 | 35.3 | 32.4 | 29.9 | 29.9 | 31.7 | 33.0 | 33.3 | 30.9 |
| | 2011 | 30.7 | 31.2 | 33.6 | 33.2 | 34.2 | 31.8 | -- | -- | -- | -- | -- | -- |
| MONTHLY MEAN MINIMUM TEMPERATURE (deg C) | 2009 | 19.4 | 19.5 | 22.5 | 24.6 | 26.7 | 27.7 | 25.6 | 26.2 | 25.8 | 24.6 | 23.8 | 22.3 |
| | 2010 | 21.3 | 21.8 | 24.2 | 26.5 | 28.5 | 26.6 | 25.3 | 25.6 | 25.9 | 25.9 | 24.9 | 20.6 |
| | 2011 | 18.6 | 20.8 | 23.4 | 25.3 | 27.6 | 26.7 | -- | -- | -- | -- | -- | -- |

TABLE 3.9
MONTHLY MEAN MAXIMUM AND MINIMUM TEMPERATURE AT STATION: SANTACRUZ

| PARAMETERS | YEAR | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC |
|---|------|------|------|------|------|------|------|------|------|------|------|------|------|
| MONTHLY MEAN MAXIMUM TEMPERATURE (deg C) | 2009 | 32.9 | 32.6 | 34.3 | 35.4 | 33.9 | 33.6 | 29.8 | 31.1 | 31.2 | 33.3 | 32.9 | 32.1 |
| | 2010 | 32.5 | 31.6 | 33.6 | 34.6 | 34.7 | 33.0 | 30.3 | 29.8 | 31.5 | 33.0 | 33.6 | 30.8 |
| | 2011 | 31.6 | 32.1 | 35.3 | 33.2 | 33.5 | 32.0 | -- | -- | -- | -- | -- | -- |
| MONTHLY MEAN MINIMUM TEMPERATURE (deg C) | 2009 | 17.9 | 18.1 | 21.8 | 25.1 | 27.3 | 27.8 | 25.4 | 26.1 | 25.4 | 23.1 | 22.1 | 19.2 |
| | 2010 | 18.8 | 19.0 | 22.2 | 24.8 | 27.8 | 26.1 | 24.9 | 25.1 | 25.2 | 24.7 | 23.4 | 17.4 |
| | 2011 | 14.9 | 17.2 | 20.1 | 23.8 | 26.8 | 26.2 | -- | -- | -- | -- | -- | -- |

FIGURE 3.7
WINDROSE DIAGRAM



3.4.2 Air Quality

The atmospheric concentrations of air pollutants were monitored at 5 locations during January 2012 by setting up ambient air quality monitoring stations. The monitoring stations were selected to generate the representative samples for air quality covering residential, institutional and industrial area along the corridor. Locations of air monitoring stations are shown in **Figure 3.2**. Air Monitoring was carried out for PM_{2.5}, PM₁₀, NO_x, SO₂, CO, and HC. Results of the air quality monitoring are presented in **Table 3.10**. The results show that the concentration of PM₁₀ and PM_{2.5} exceeds the standards at all locations whereas other parameters are within permissible limits at all the locations.

**TABLE 3.10
AMBIENT AIR QUALITY RESULTS**

| Location | Date | Timing | PM ₁₀ µg/m ³ | PM _{2.5} µg/m ³ | NO _x µg/m ³ | SO ₂ µg/m ³ | (HC) (ppm) | CO (mg/m ³) |
|---------------------------|--------------------------------|----------------------|---------------------------------------|--|--------------------------------------|--------------------------------------|---------------|----------------------------|
| Limits As per CPCB (MoEF) | | | 100 | 60 | 80 | 80 | -- | 2 |
| Mahim | 10/01/2012 To 11/01/2012 | 01:30 PM To 09:30 PM | 247 | 151 | 40.1 | 12.3 | 3.4 | 1.35 |
| | | 09:30 PM To 05:30 AM | 143 | 85 | 20.0 | < 5.0 | 2.5 | 1.13 |
| | | 05:30 AM To 01:30 PM | 211 | 124 | 32.2 | 8.4 | 3.1 | 1.22 |
| BKC | 11/01/2012 To 12/01/2012 | 03:00PM To 11:00 PM | 235 | 140 | 31.2 | 6.2 | 3.0 | 1.28 |
| | | 11:00 PM To 07:00 AM | 138 | 81 | 26.5 | < 5.0 | 2.4 | 1.11 |
| | | 07:00 AM To 03:00 PM | 304 | 135 | 37.1 | 9.4 | 4.1 | 1.43 |
| SEEPZ | 12/01/2012 To 13/01/2012 | 03:00PM To 11:00 PM | 185 | 109 | 19.2 | < 5.0 | 2.3 | 1.10 |
| | | 11:00 PM To 07:00 AM | 112 | 60 | 15.0 | < 5.0 | 2.3 | 1.00 |
| | | 07:00 AM To 03:00 PM | 230 | 140 | 24.1 | 6.5 | 2.9 | 1.24 |
| Colaba | 13/01/2012 To 14/01/2012 | 04:00 PM To 12:00 AM | 325 | 213 | 37.1 | 7.4 | 3.8 | 1.34 |
| | | 12:00 PM To 08:00 AM | 189 | 98 | 22.4 | < 5.0 | 2.7 | 1.18 |
| | | 08:00 AM To 04:00 PM | 387 | 250 | 39.8 | 8.2 | 4.0 | 1.42 |
| Airport | 14/01/2012 To 15/01/2012 | 05:00PM To 01:00 AM | 311 | 185 | 35.6 | 9.5 | 4.5 | 1.45 |
| | | 01:00 AM To 09:00 AM | 241 | 142 | 28.1 | 6.5 | 2.9 | 1.23 |
| | | 09:00 AM To 05:00 PM | 388 | 236 | 41.0 | 11.3 | 4.2 | 1.42 |

An ambient air quality data for pre monsoon (i.e months of February & March) and post monsoon (i.e months of September & October) for the year 2011 has been collected at Worli, Khar and Andheri. The data has been procured from Air Quality Monitoring and Research Laboratory, Khar and Maharashtra Pollution Control Board, Mumbai. The air quality data namely SPM, SO₂, NO₂ and NH₃ has been graphically presented in **Figure 3.8** to **Figure 3.27**.

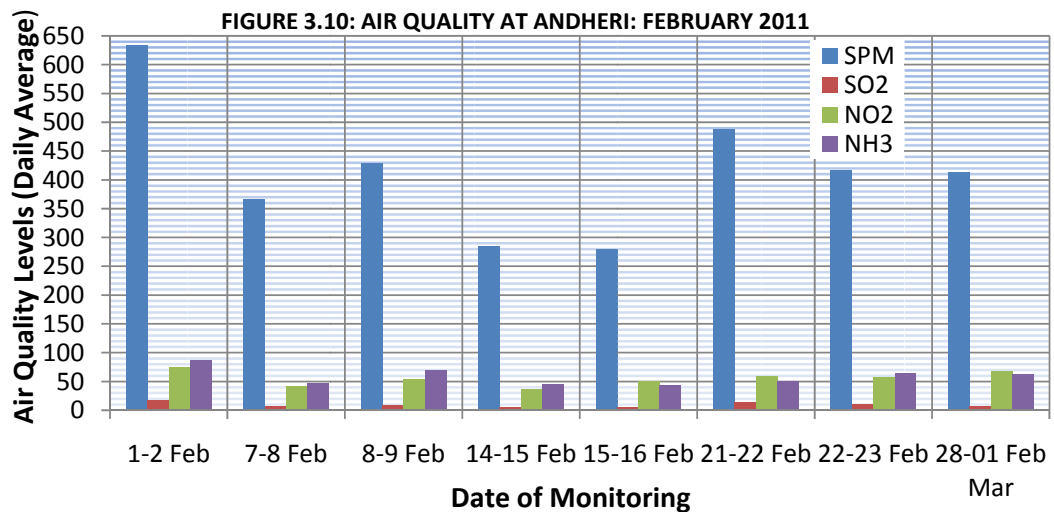
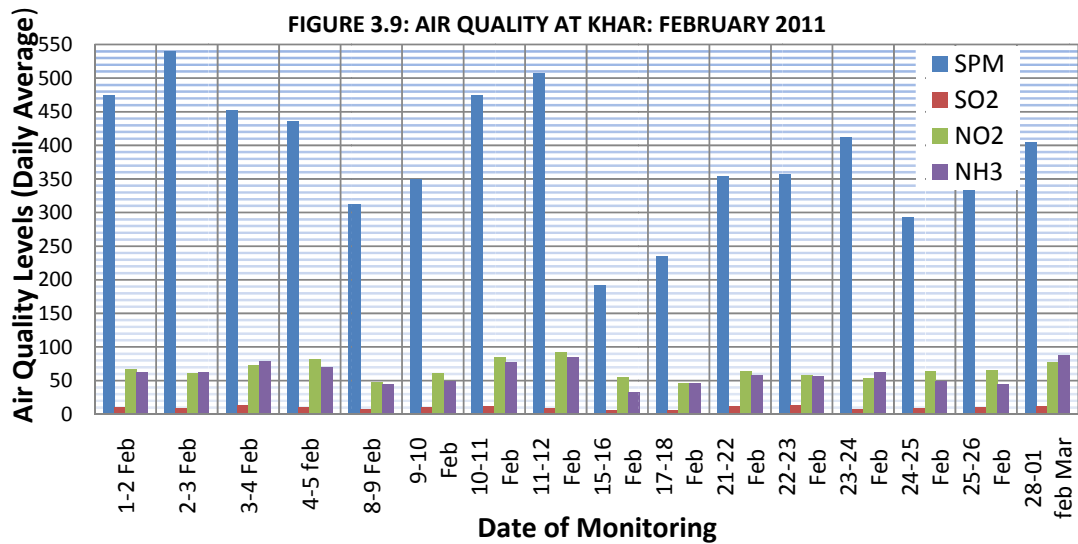
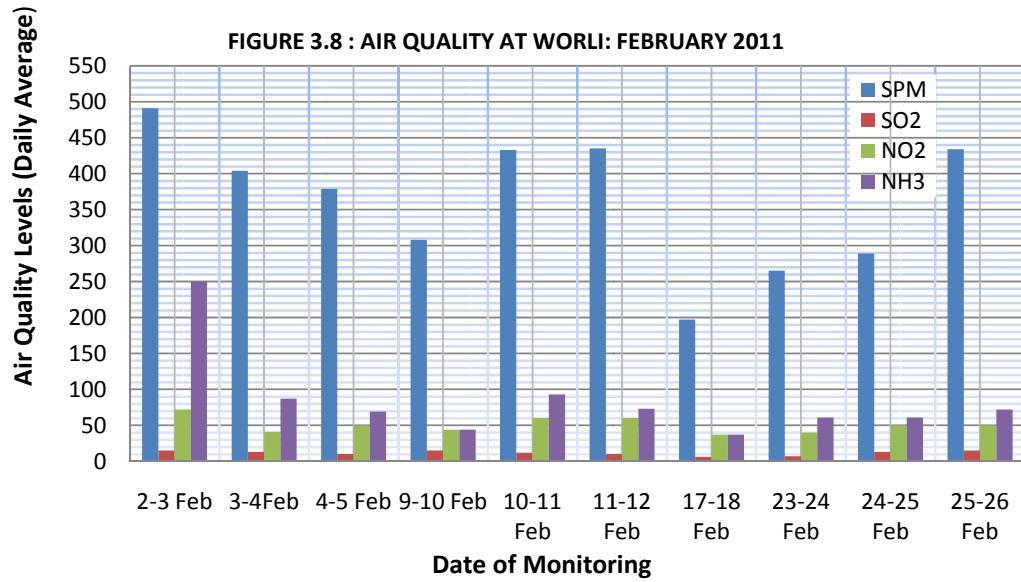


FIGURE 3.11: AIR QUALITY AT BANDRA: FEBRUARY 2011

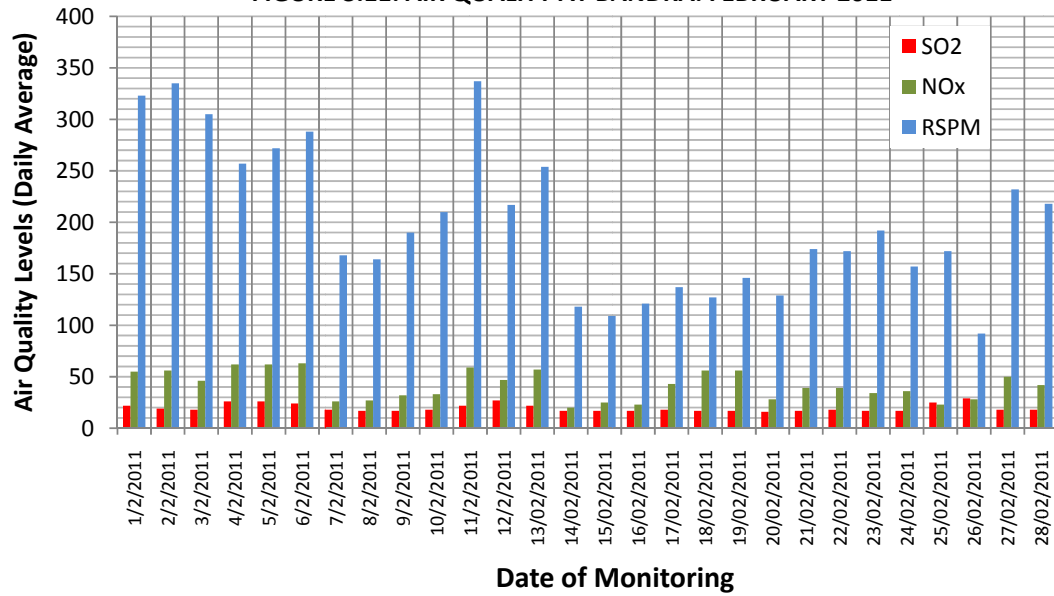


FIGURE 3.12: AIR QUALITY AT KALBADEVI: FEBRUARY 2011

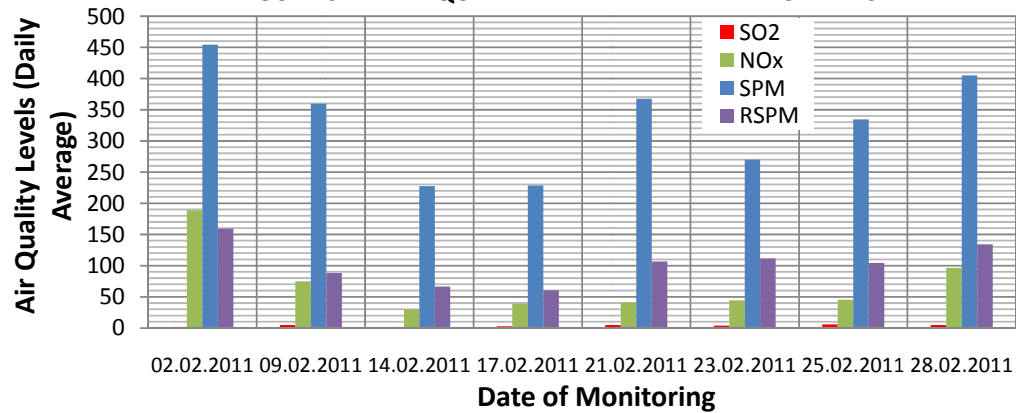


FIGURE 3.13: AIR QUALITY AT WORLI: MARCH 2011

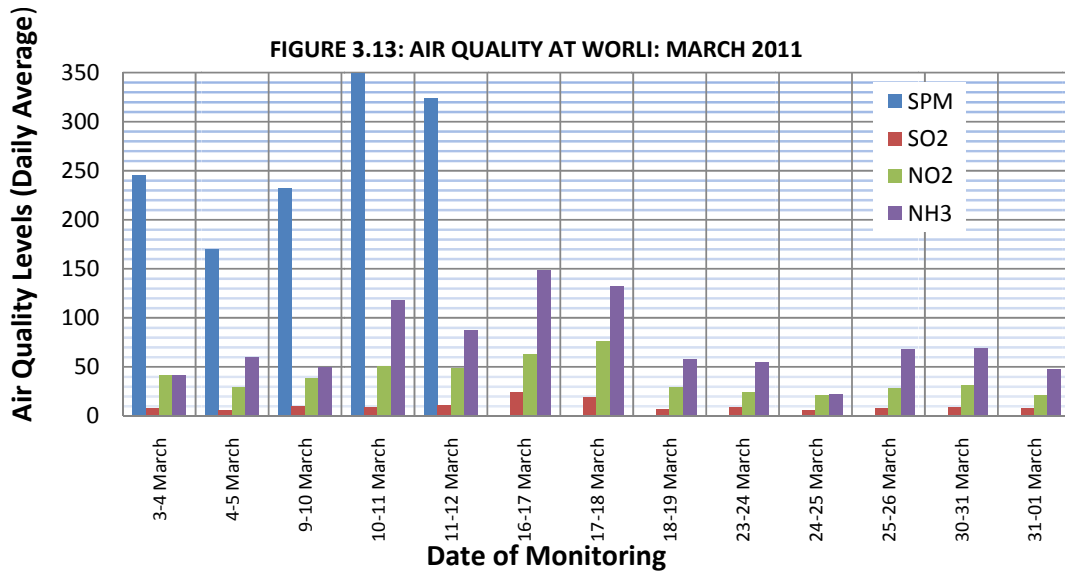


FIGURE 3.14: AIR QUALITY AT KHAR: MARCH 2011

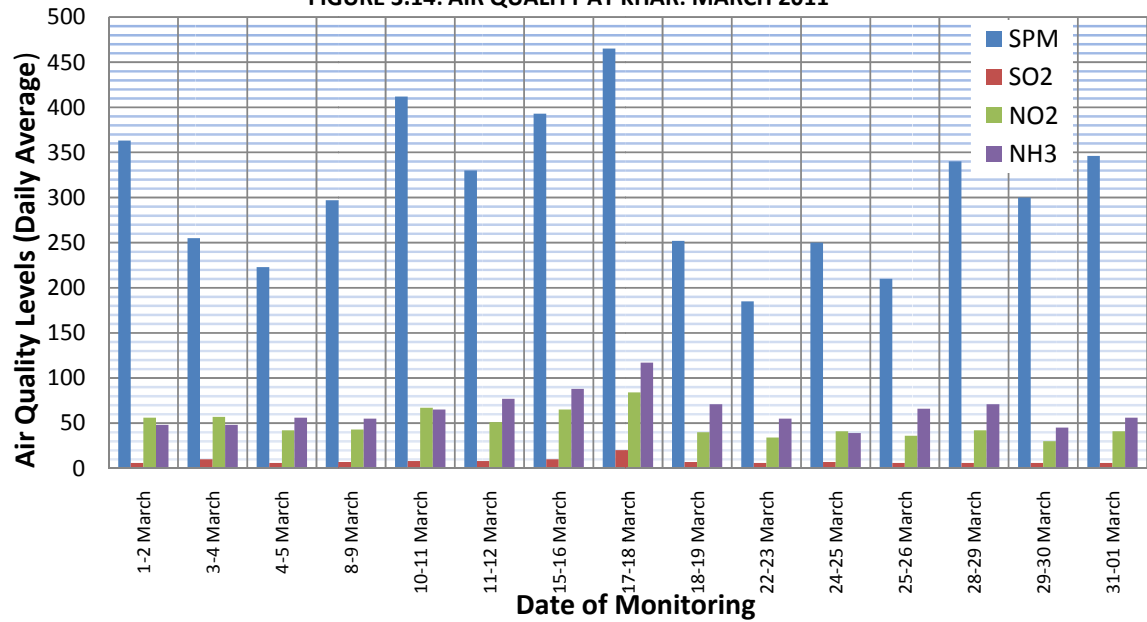


FIGURE 3.15: AIR QUALITY AT ANDHERI: MARCH 2011

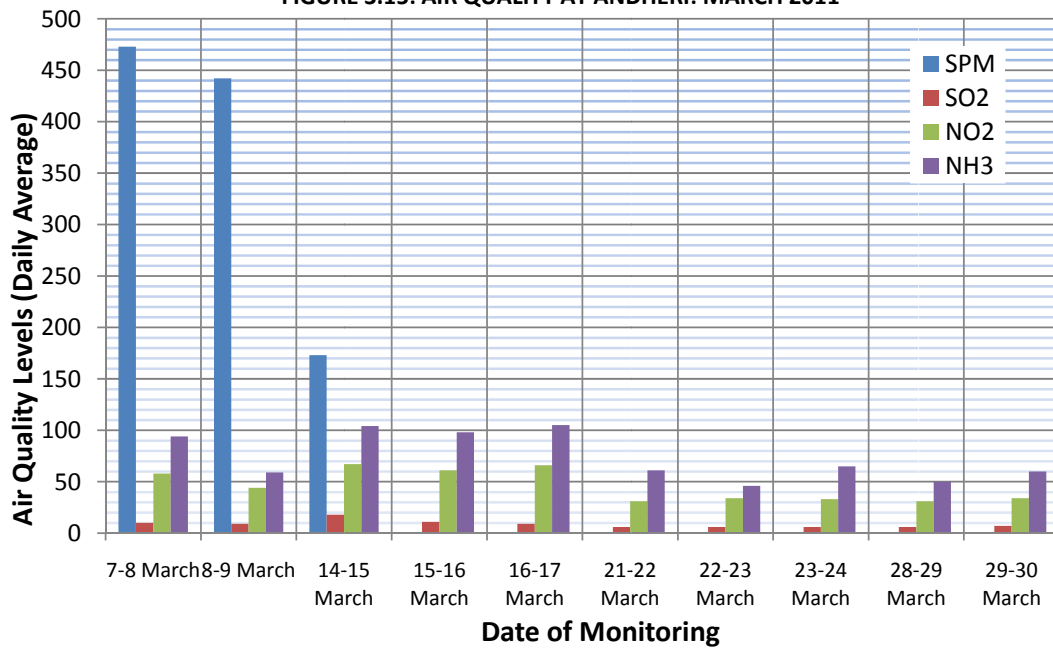


FIGURE 3.16: AIR QUALITY AT BANDRA: MARCH 2011

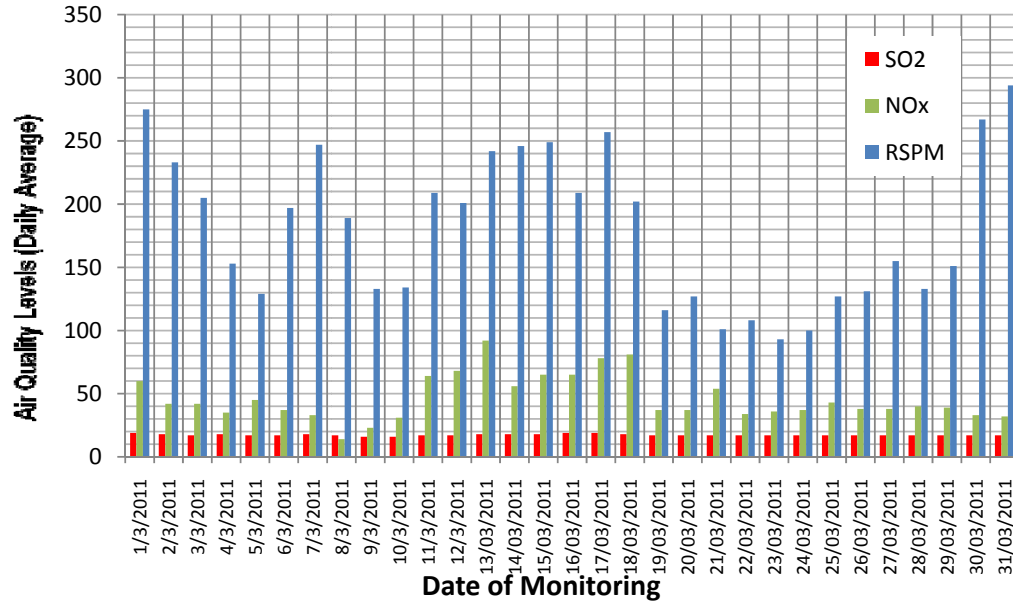


FIGURE 3.17: AIR QUALITY AT KALBADEVI: MARCH 2011

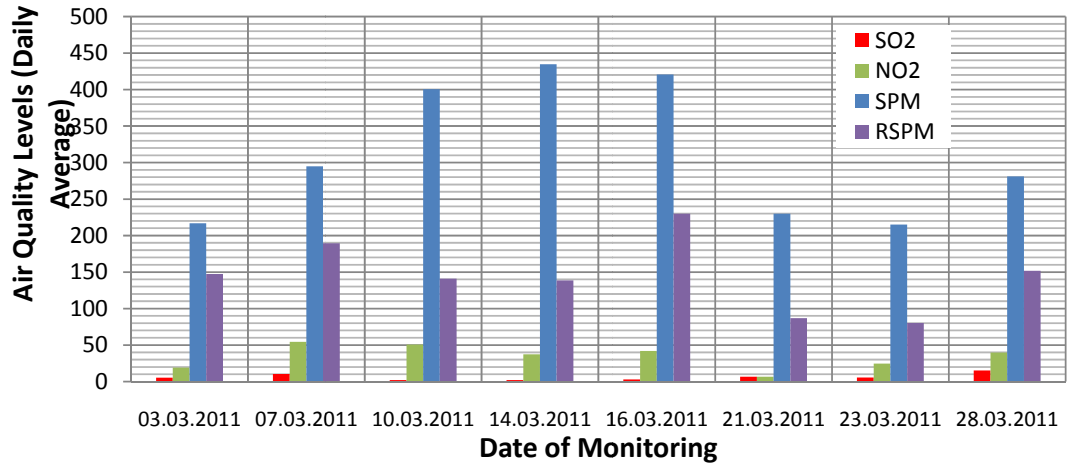


FIGURE 3.18: AIR QUALITY AT WORLI: SEPTEMBER 2011

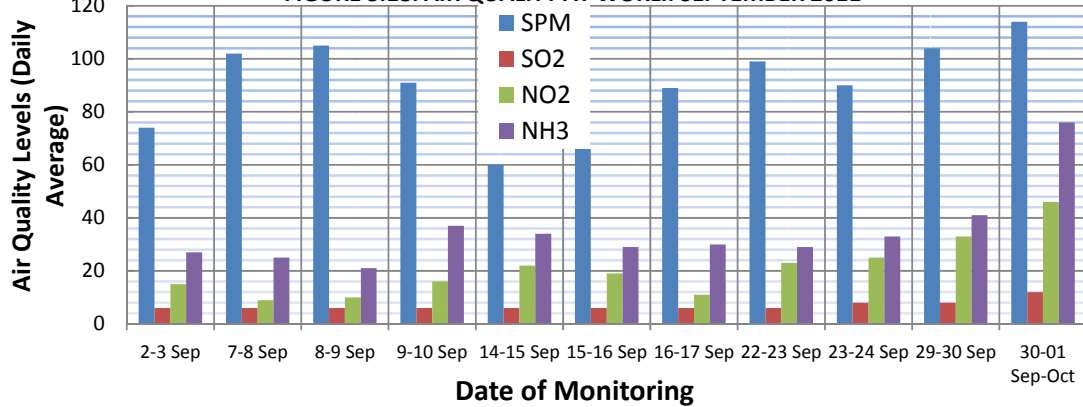


FIGURE 3.19: AIR QUALITY AT KHAR: SEPTEMBER 2011

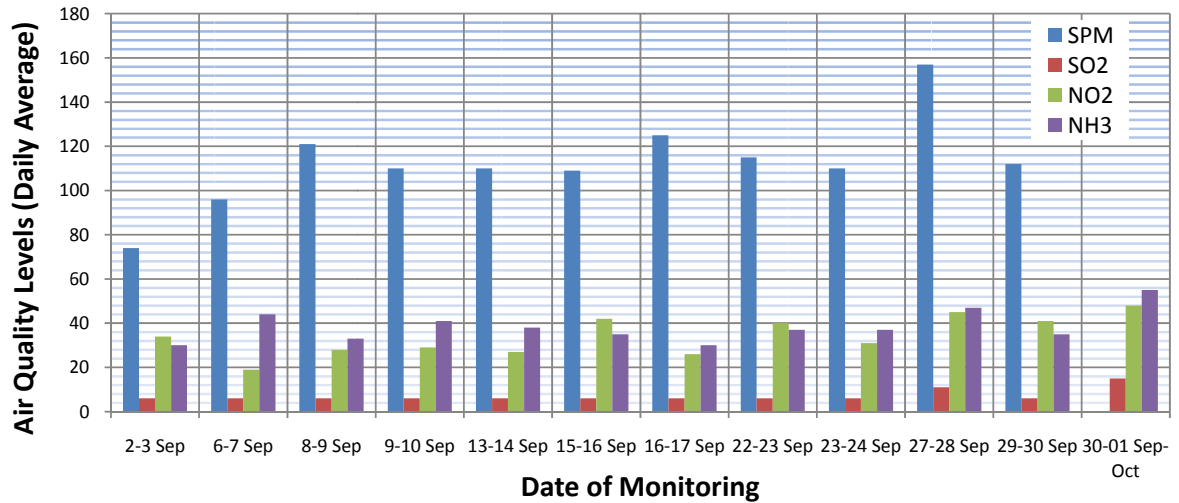


FIGURE 3.20: AIR QUALITY AT ANDHERI: SEPTEMBER 2011

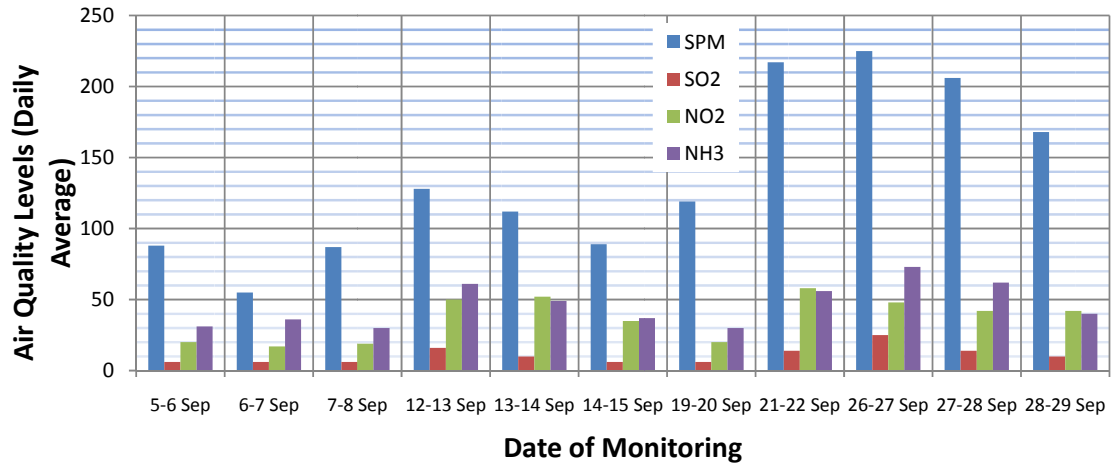
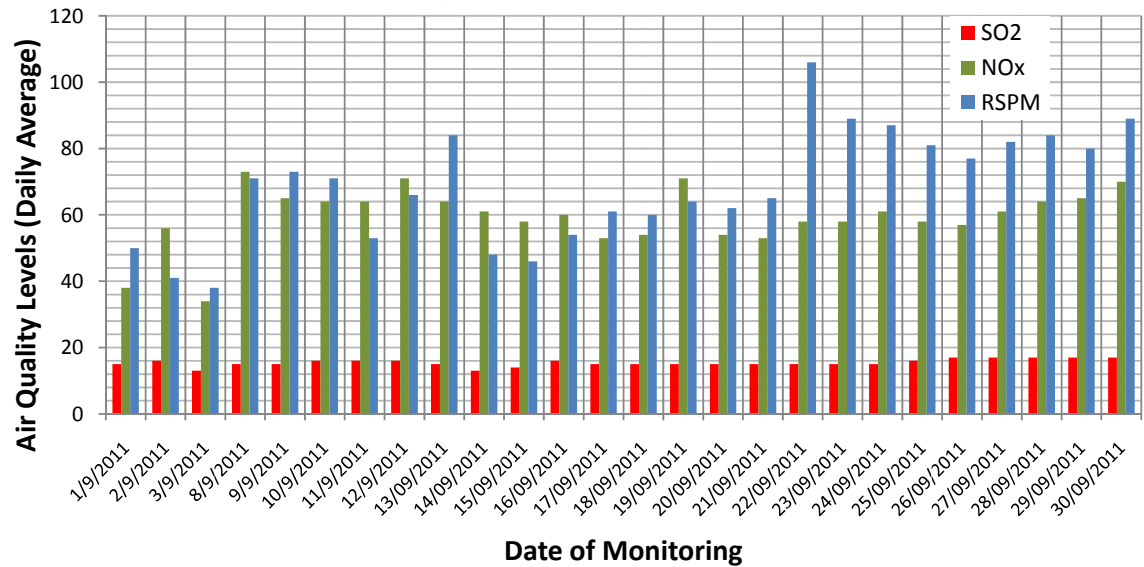


FIGURE 3.21: AIR QUALITY AT BANDRA: SEPTEMBER 2011



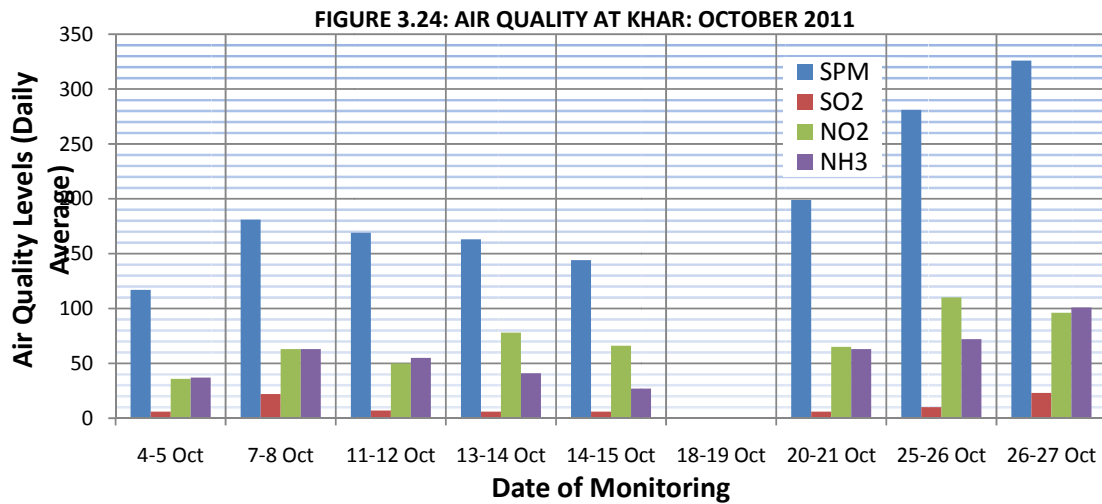
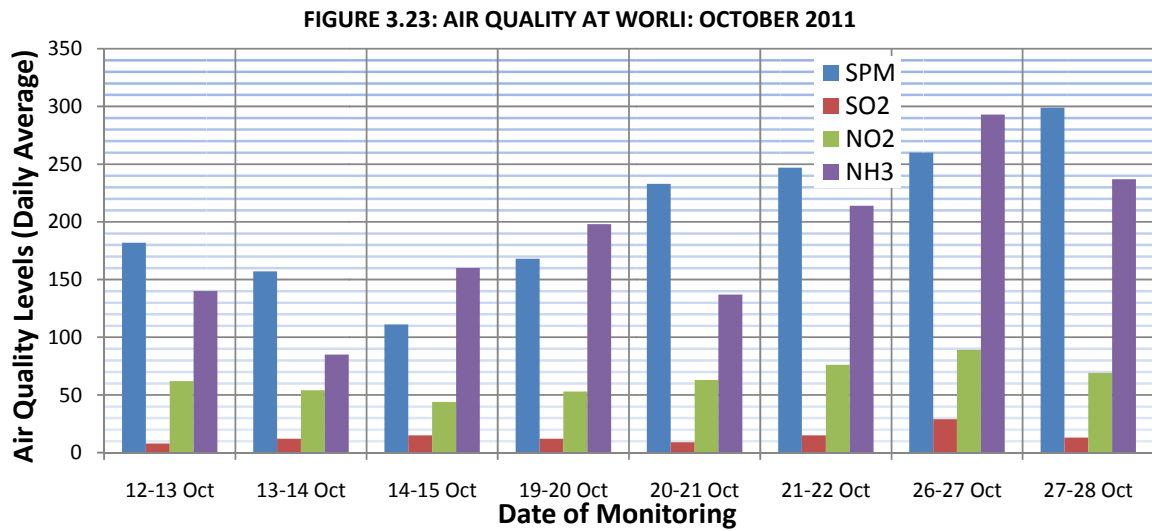
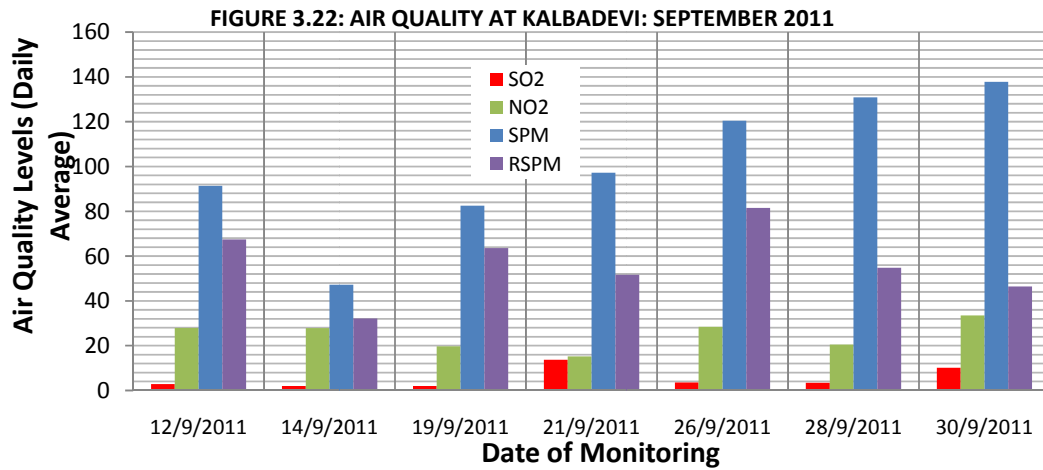


FIGURE 3.25: AIR QUALITY AT ANDHERI: OCTOBER 2011

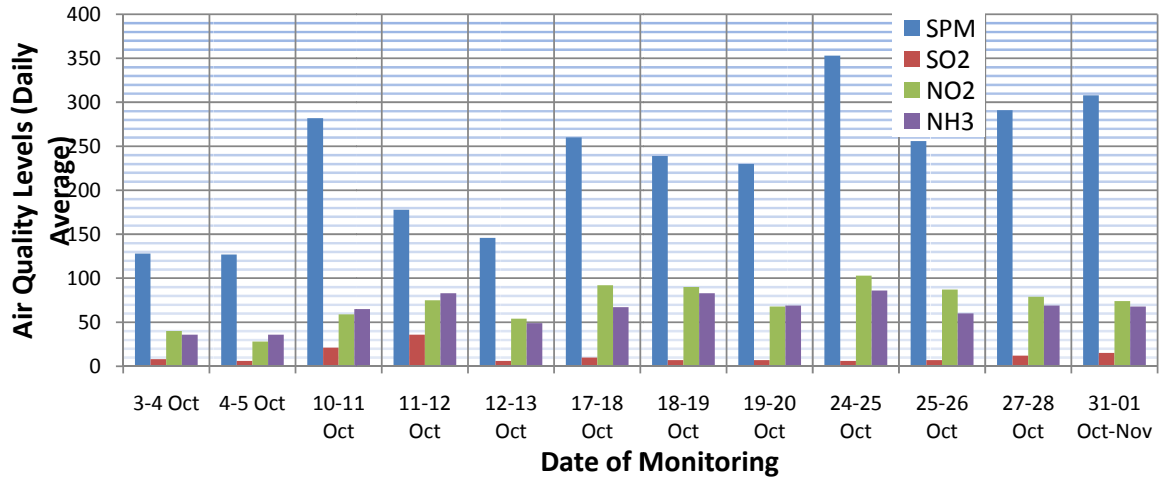


FIGURE 3.26: AIR QUALITY AT BANDRA: OCTOBER 2011

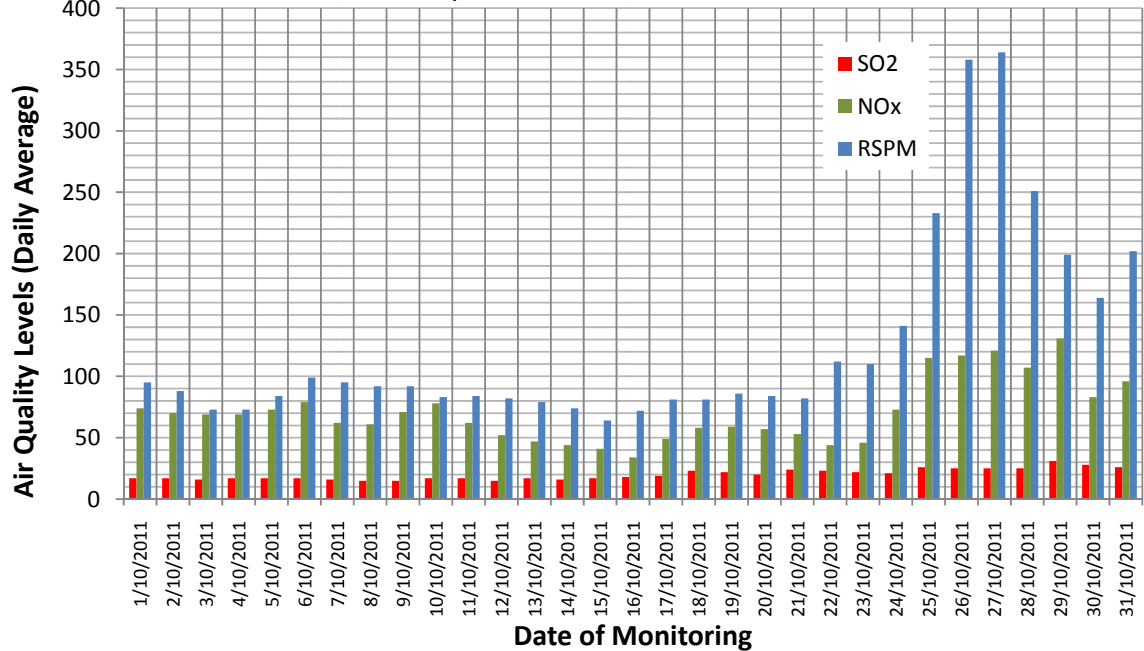
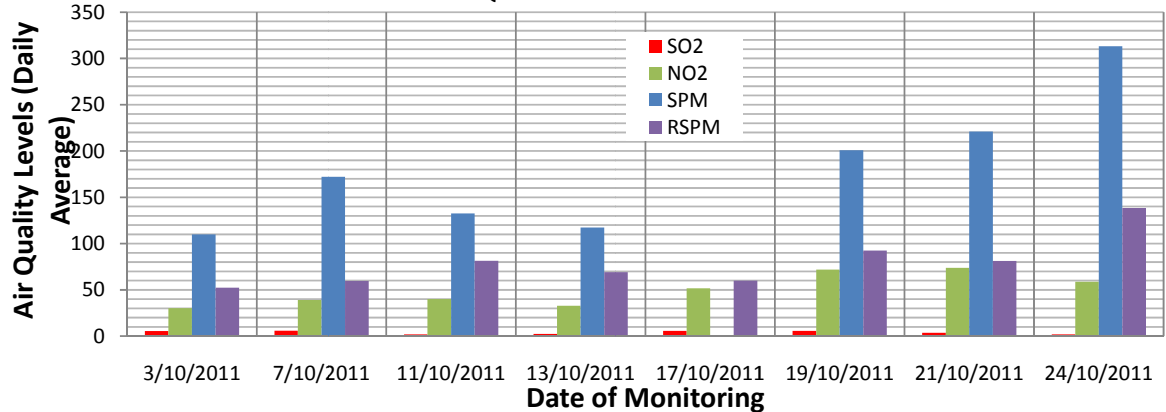


FIGURE 3.27: AIR QUALITY AT KALBADEVI: OCTOBER 2011



3.5 NOISE ENVIRONMENT

Noise pollution is caused by an unwanted sound that is produced by various natural or man-made sources such as oceans, construction, industrial, transportation etc. Noise can have any adverse affects such as hearing impairment; sleep disturbance, interference with speech communication, reduced performance, annoyance and harming physiological functions.

Noise pollution is regarded as a public nuisance under Sections 268, 290 and 291 of the Indian Penal Code. There are several other legislations relating to noise pollution such as The Factories Act, 1948 (under which 'noise induced hearing loss' is notified as a disease); Motor Vehicles Act, 1988 (which specifies rules for horns and silencers); Law of Torts (civil suits can be filed for claiming damages); The Air (Prevention and Control of Pollution) Act, 1981 (ambient noise standards have been given), The Environment (Protection) Act, 1986; Noise Pollution (Regulation and Control) Rules, 2000 and regulations in respect of Loudspeakers/Public Address System. Further, there are standards and guidelines for ambient noise quality, automobiles, domestic appliances and construction equipment, generator sets, and firecrackers as notified under the Environment (Protection) Act, 1986. In general, continued exposure to noise levels above 85 dB would cause hearing loss over time. However, noise above 140 dB could cause aural damage after just one exposure. As a safeguard against harmful noise level, the CPCB has specified standards for various categories of areas as given below in Table.

Noise level survey was conducted along the alignment with an objective to establish the baseline noise levels and assess the impacts of total noise expected due to the proposed metro. Noise levels were measured at five locations as shown in Figure 3.2. Hourly Noise levels were recorded at 2 m away from source as per standard practice. Sampling duration were taken on hourly basis in the time bracket of 08-10,12-14,16-18,20-22 & 24-02 hours in order to have an assessment of the Day and Night time noise levels. The results of the noise quality were reported as L_{eq} , L_{10} , L_{50} , L_{90} , L_{max} , L_{min} , L_{day} , L_{night} , L_{DN} . The noise levels so obtained are summarised in **Table 3.11**. The results of observations indicate that the equivalent noise levels at all the five sites are more than the limit prescribed for residential areas.

**TABLE 3.11
NOISE LEVELS**
Date: 10/01/2012 to 11/01/2012
Location: Mahim

| Time | Hourly Leq dB (A) | Result dB (A) | |
|----------|-------------------|---------------|------|
| MIDNIGHT | 52.8 | Leq(24hrs.) | 67.0 |
| 1:00 AM | 50.2 | L10 | 72.7 |
| 2 | 49.5 | L50 | 69.5 |
| 3 | 52.9 | L90 | 67.5 |
| 4 | 49.3 | Lday | 68.3 |
| 5 | 55.9 | Lnight | 60.9 |
| 6 | 59.7 | Ldn | 69.4 |
| 7 | 63.3 | Lmax | 74.1 |
| 8 | 65.1 | Lmin | 49.3 |
| 9 | 66.4 | | |
| 10 | 68.2 | | |
| 11 | 69.4 | | |
| 12 NOON | 73.2 | | |
| 13 | 74.1 | | |
| 14 | 68.3 | | |
| 15 | 67.4 | | |
| 16 | 69.2 | | |
| 17 | 68.7 | | |
| 18 | 65.3 | | |
| 19 | 64.2 | | |
| 20 | 63.4 | | |
| 21 | 68.2 | | |
| 22 | 63.7 | | |
| 23 | 58.2 | | |

Date: 11/01/2012 to 12/01/2012
Location: BKC

| Time | Hourly Leq dB (A) | Result dB (A) | |
|----------|-------------------|---------------|------|
| MIDNIGHT | 51.2 | Leq(24hrs.) | 68.6 |
| 1:00 AM | 49.4 | L10 | 73.4 |
| 2 | 48.3 | L50 | 71.4 |
| 3 | 47.1 | L90 | 69.2 |
| 4 | 49.6 | Lday | 70.3 |
| 5 | 52.4 | Lnight | 53.0 |
| 6 | 58.9 | Ldn | 68.9 |
| 7 | 61.3 | Lmax | 74.3 |
| 8 | 65.3 | Lmin | 47.1 |
| 9 | 68.2 | | |
| 10 | 72.4 | | |
| 11 | 69.7 | | |
| 12 NOON | 74.3 | | |
| 13 | 72.6 | | |
| 14 | 73.1 | | |
| 15 | 68.3 | | |
| 16 | 72.8 | | |
| 17 | 71.4 | | |
| 18 | 70.1 | | |
| 19 | 69.9 | | |
| 20 | 68.6 | | |
| 21 | 59.3 | | |
| 22 | 52.7 | | |
| 23 | 50.8 | | |

Date: 12/01/2012 to 13/01/2012
Location: SEEPZ

| Time | Hourly Leq dB (A) | Result dB (A) | |
|----------|-------------------|---------------|------|
| MIDNIGHT | 45.3 | Leq(24hrs.) | 65.9 |
| 1:00 AM | 43.9 | L10 | 72.9 |
| 2 | 44.8 | L50 | 68.9 |
| 3 | 45.7 | L90 | 66.5 |
| 4 | 46.9 | Lday | 67.7 |
| 5 | 49.3 | Lnight | 46.5 |
| 6 | 52.7 | Ldn | 66.1 |
| 7 | 53.9 | Lmax | 73.9 |
| 8 | 55.6 | Lmin | 43.9 |
| 9 | 59.8 | | |
| 10 | 62.5 | | |
| 11 | 64.3 | | |
| 12 NOON | 65.9 | | |
| 13 | 68.7 | | |
| 14 | 66.5 | | |
| 15 | 70.2 | | |
| 16 | 71.7 | | |
| 17 | 73.9 | | |
| 18 | 72.7 | | |
| 19 | 64.3 | | |
| 20 | 50.9 | | |
| 21 | 49.4 | | |
| 22 | 47.9 | | |
| 23 | 45.1 | | |

Date: 13/01/2012 to 14/01/2012
Location: Colaba

| Time | Hourly Leq dB (A) | Result dB (A) | |
|----------|-------------------|---------------|------|
| MIDNIGHT | 49.3 | Leq(24hrs.) | 68.2 |
| 1:00 AM | 48.4 | L10 | 74.3 |
| 2 | 46.5 | L50 | 71.1 |
| 3 | 43.8 | L90 | 68.8 |
| 4 | 49.3 | Lday | 69.9 |
| 5 | 55.6 | Lnight | 50.5 |
| 6 | 57.4 | Ldn | 68.4 |
| 7 | 59.3 | Lmax | 74.9 |
| 8 | 63.5 | Lmin | 43.8 |
| 9 | 61.9 | | |
| 10 | 65.9 | | |
| 11 | 68.2 | | |
| 12 NOON | 70.8 | | |
| 13 | 72.9 | | |
| 14 | 74.3 | | |
| 15 | 73.7 | | |
| 16 | 68.0 | | |
| 17 | 74.9 | | |
| 18 | 73.0 | | |
| 19 | 62.3 | | |
| 20 | 58.2 | | |
| 21 | 56.8 | | |
| 22 | 52.1 | | |
| 23 | 48.4 | | |

Date: 14/01/2012 to 15/01/2012

Location: Airport

| Time | Hourly Leq dB (A) | Result dB (A) | |
|----------|-------------------|---------------|------|
| MIDNIGHT | 52.3 | Leq(24hrs.) | 68.6 |
| 1:00 AM | 55.1 | L10 | 74.5 |
| 2 | 68.4 | L50 | 71.3 |
| 3 | 70.2 | L90 | 69.1 |
| 4 | 64.1 | Lday | 68.6 |
| 5 | 75.6 | Lnight | 68.5 |
| 6 | 73.2 | Ldn | 74.6 |
| 7 | 69.2 | Lmax | 75.6 |
| 8 | 62.0 | Lmin | 49.6 |
| 9 | 71.8 | | |
| 10 | 69.3 | | |
| 11 | 63.2 | | |
| 12 NOON | 70.2 | | |
| 13 | 65.2 | | |
| 14 | 59.8 | | |
| 15 | 63.4 | | |
| 16 | 74.5 | | |
| 17 | 70.1 | | |
| 18 | 63.8 | | |
| 19 | 59.2 | | |
| 20 | 55.7 | | |
| 21 | 52.1 | | |
| 22 | 50.0 | | |
| | 49.6 | | |

NATIONAL AMBIENT NOISE STANDARDS

| TEGORY OF ZONES | Leq IN dB (A) | |
|-----------------|---------------|-------|
| | DAY * | NIGHT |
| Industrial | 75 | 70 |
| Commercial | 65 | 55 |
| Residential | 55 | 45 |
| Silence Zone ** | 50 | 40 |

Source: Central Pollution Control Board,

* Daytime is from 6.00 AM to 9.00 PM.,

** Silence Zone is defined as an area up to 100m around premises of Hospitals, Educational Institutions and Courts. Use of vehicle horn, loudspeaker and bursting of crackers is banned in these zones.

3.6 Vibration

The sources of the vibration and noise are due to operation of Tunnel Boring Machine (TBM) during construction of tunnel. Vibration induced by the metro train during operation is mainly due to the rolling stock, track and the interaction between them. Continuous effect of vibration on the buildings can cause damage to buildings. Building subjected to the vibration effect with more than 50 mm/s would receive structural damage. Historic buildings are more susceptible to vibration effect due to type of building material and design. The vibration induced by the operation of train first causes the vibration of track structure as well as tunnel structure, and then, propagate through the strata to the surrounding environment.

Human response to vibration is subjective and will be different for different people. When the vibrations reach the floors and walls it may result in perceptible vibration depending on the amplitude and frequency of the vibrations. Rattling of windows, dishes, and similar parts may also result in audible noise which is called ground-borne noise. People may be more annoyed if they are exposed to both noise and vibration compared to when only vibration is felt. According to the U.S. Department of Transportation, (1998) the perception threshold of humans for peak particle velocity is about 0.04 mm/s (65VdB with reference 1e-6 inch/sec).

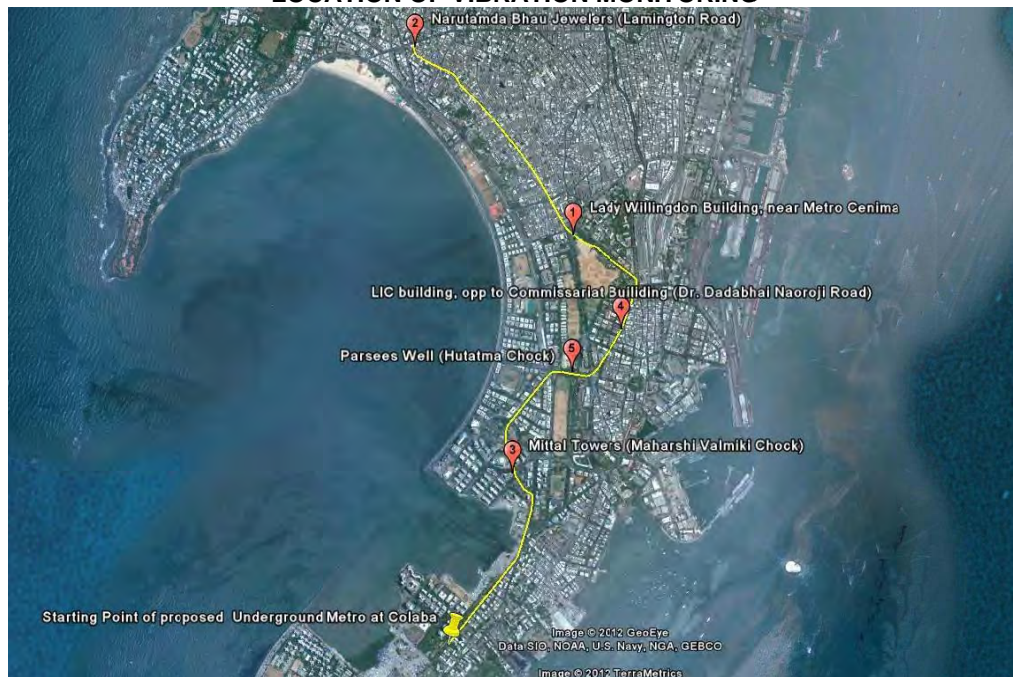
To know the impact of vibration due to TBM operation on the existing structures and due to metro train operation has been studied at six locations by selecting the most sensitive

area falling on the proposed metro line alignment. The monitoring was carried out using the Nomis Seismograph equipment which can measure the radial, transverse and vertical vibration of ground borne vibration. The detail of location where vibration monitoring has been carried out is given in **Table 3.12** and shown in Google map as **Figure 3.28**. The hard rock structure will be considered while predicting the vibration impact as the proposed metro is 18 to 20 m below the ground level.

TABLE 3.12
VIBRATION MONITORING LOCATION

| SI | LOCATION | LATITUDE | LONGITUDE |
|----|--|------------------|------------------|
| 1 | Lady Willingdon Building, Dhobi Talao, near Metro Cenima. Mahapalika Road. | 18° 56' 34.64" N | 72° 49' 46.57" E |
| 2 | Narutamdas Bhau Jewelers, K.Gajanan Vertak Chowk, Lamington Road. | 18° 57' 24.59" N | 72° 48' 59.58" E |
| 3 | Mittal Towers, Maharshi Valmiki Chowk. Press Journal Marg. | 18° 55' 30.94" N | 72° 49' 30.37" E |
| 4 | Central Assurance Building, opp to Commissariat Building, Dr. Dadabhai Naoroji Road. | 18° 56' 9.74" N | 72° 50' 1.24" E |
| 5 | Bhikha, Behram, Parsees Well, Hutatma Chowk. | 18° 55' 58.24" N | 72° 49' 46.95" E |
| 6 | Chhatrapati Shivaji Terminus (CST), Mumbai. Vir Nariman Road. | 18° 56' 23.30" N | 72° 50' 06.01" E |

FIGURE 3.28
LOCATION OF VIBRATION MONITORING



The subsequent section describes the results of field monitoring, vibration analysis, and impact assessment with the prediction of vibration due to TBM and train traffic. The vibration studies have been conducted to know the existing vibration cause due to the road traffic. The study has been conducted during the busy traffic hours at morning and

evening time. The detail description of vibration analysis of each monitoring location is as follows:

3.6.1 Vibration Monitoring at Location 1: Lady Willingdon Building, Dhobi Talao

The Lady Willingdon Building at Dhobi Talao, Mumbai was constructed in 1934; the building won an award from the Heritage Society in 1993 for being in good shape even though it was more than 60 years old at the time. The vibration monitoring has been carried out in front of the building for about 8 hr on 23/01/2012. The location of the monitoring point is shown in **Figure 3.29**. The monitoring location falls at chainage no. 4400.00 of proposed metro alignment. As per the field observation about 3400 vehicles per hour pass by this chowk, that includes all type of vehicles including two, three and four wheelers.

FIGURE 3.29
VIBRATION MONITORING AT LOCATION LADY WILLINGDON BUILDING, DHOBI TALAO



The graph of the radial vibration, transverse and vertical vibration has been plotted and shown in **Figure 3.30**, **Figure 3.31** & **Figure 3.32** respectively. The result of the monitoring shows that, the average radial vibration is below 5 mm/s which are quite normal vibration due to road traffic. At one point, we have observed peak radial vibration of 25 mm/s, this may be due to some passage of heavy vehicle. The average transverse vibration is found to be between 5 to 10 mm/s. The average vertical vibration is found to be below 5mm/s. During monitoring it was observed that there was a sudden rise in the

vertical vibration of about 28 mm/s at a frequency 204 Hz which could be due to passing of heavy vehicle.

FIGURE 3.30
RADIAL VIBRATION AT LADY WILLINGDON BUILDING, DHOBI TALAO

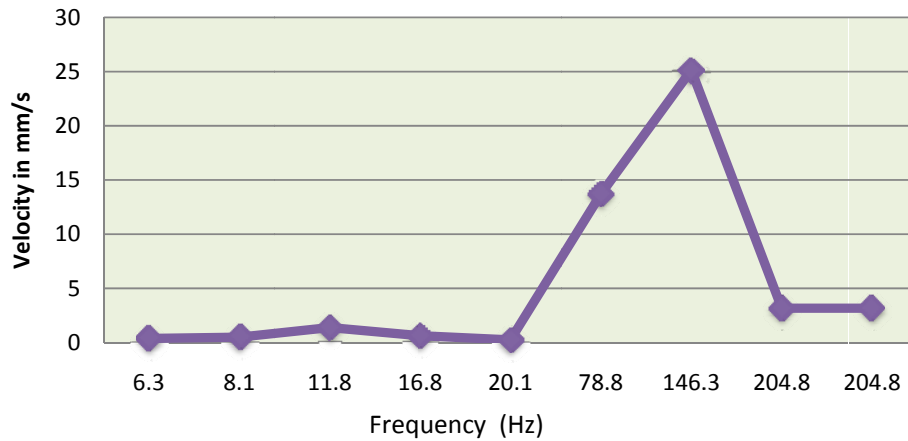


FIGURE 3.31
TANSVERSE VIBRATION AT LADY WILLINGDON BUILDING DHOBI TALAO

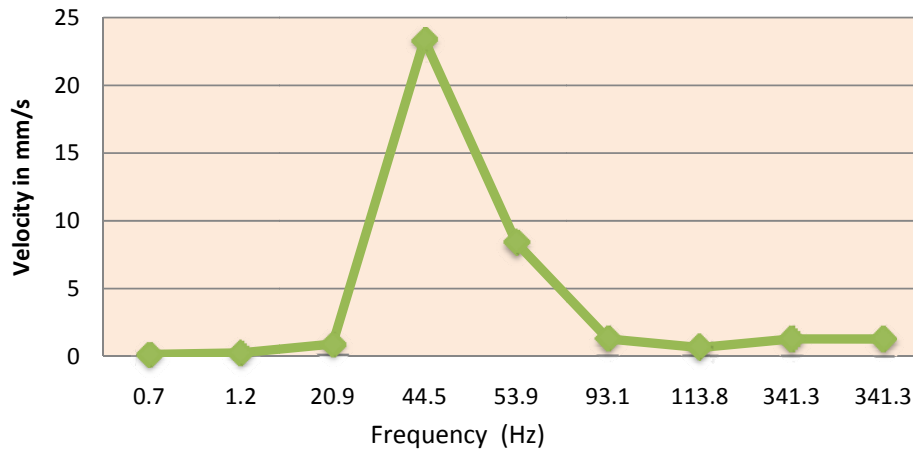
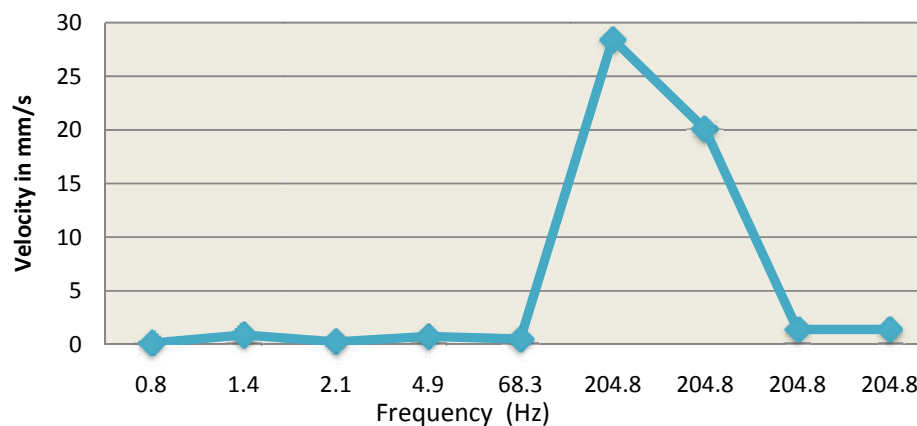


FIGURE 3.32
VERTICAL VIBRATION AT LADY WILLINGDON BUILDING DHOBI TALAO



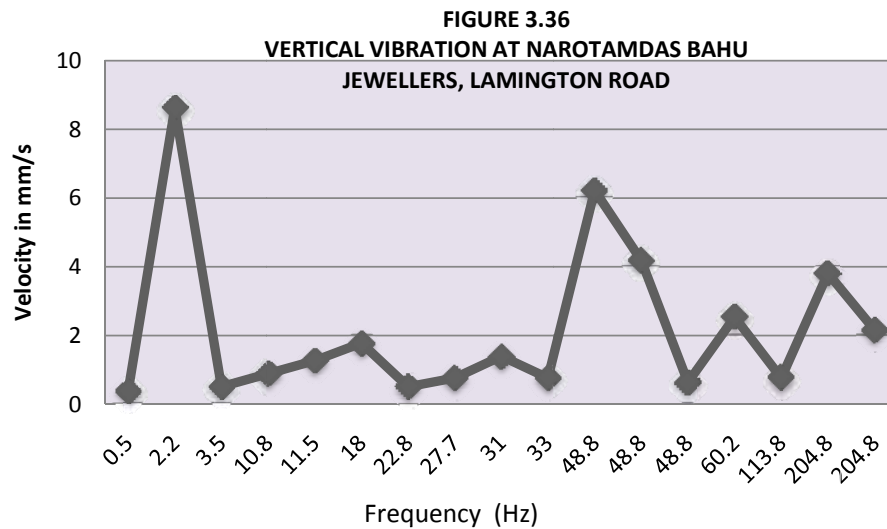
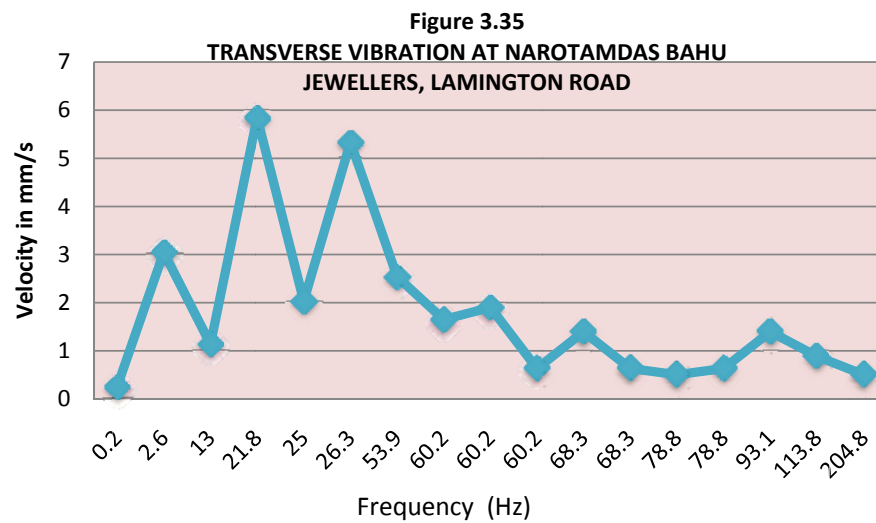
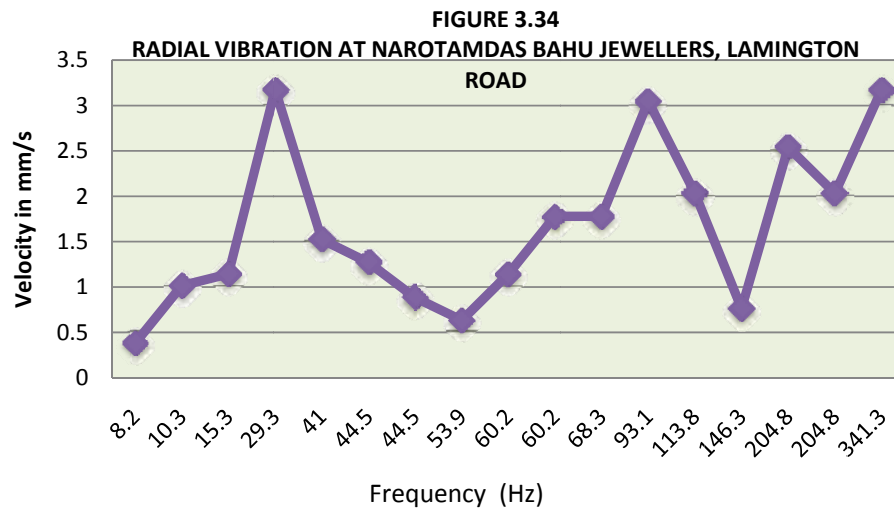
3.6.2 Vibration Monitoring at Location 2: Narutamdas Bhau Jewelers, K.Gajanan Vertak Chowk, Lamington Road

K.Gajanan Vertak Chowk is located at Lamington road, Mumbai. Narutamdas Bhau Jewelers building is more than 100 year old located at the K. Gajanan Vertak Chowk. There are many old structures that are closely located at this chowk. The monitoring location falls at chainage no. 6500.00 of proposed metro alignment. As per the field observation about 3000 vehicles per hour pass by this chowk that includes all type of vehicles including two, three and four wheelers. The location of the monitoring is shown in Figure 3.33.

FIGURE 3.33
VIBRATION MONITORING AT LOCATION LAMINGTON ROAD



The graph of the radial vibration, transverse and vertical vibration has been plotted and shown in **Figure 3.34**, **Figure 3.35** & **Figure 3.36** respectively. The result of the monitoring shows the fluctuation in the radial vibration ranging 0.5 mm/s to 3.0 mm/s which is because of variation in traffic flow as well as the source is closely located with the point of monitoring. The average transverse vibration is found to be between 0.5 to 6 mm/s. The peak vertical vibration of the study location is found to be below 8.8mm/s this may be due to passing of heavy vehicle.



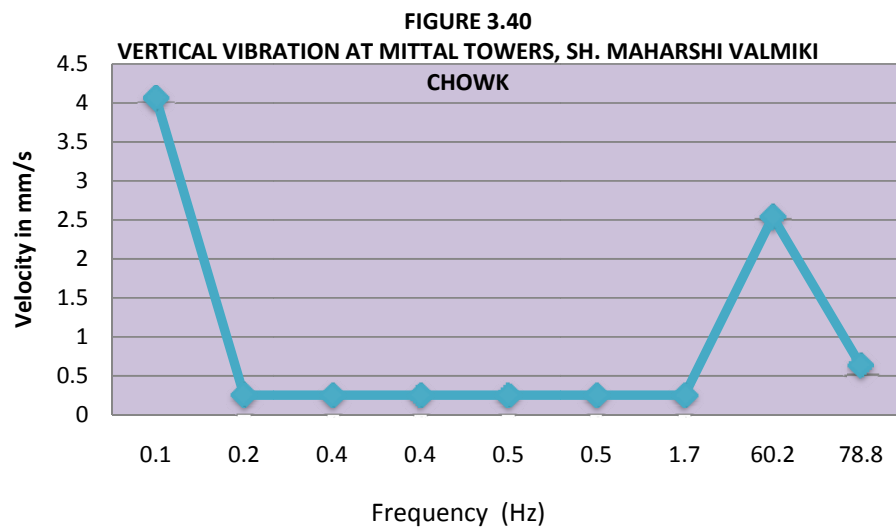
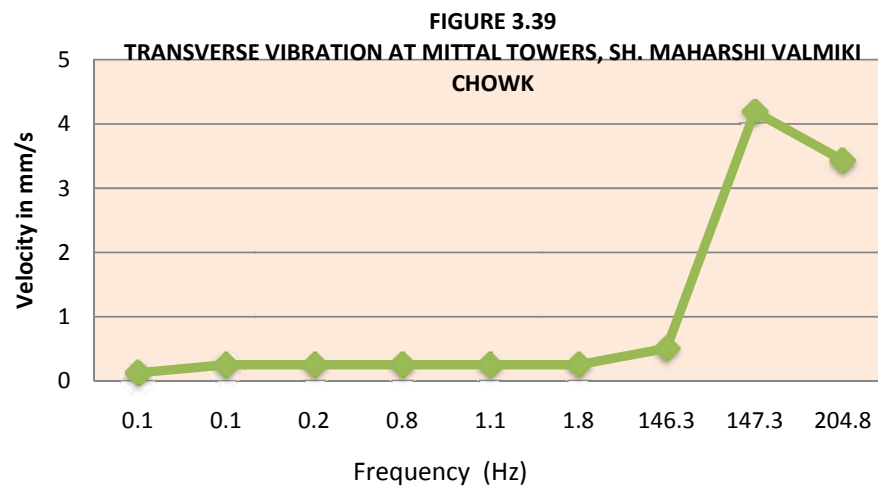
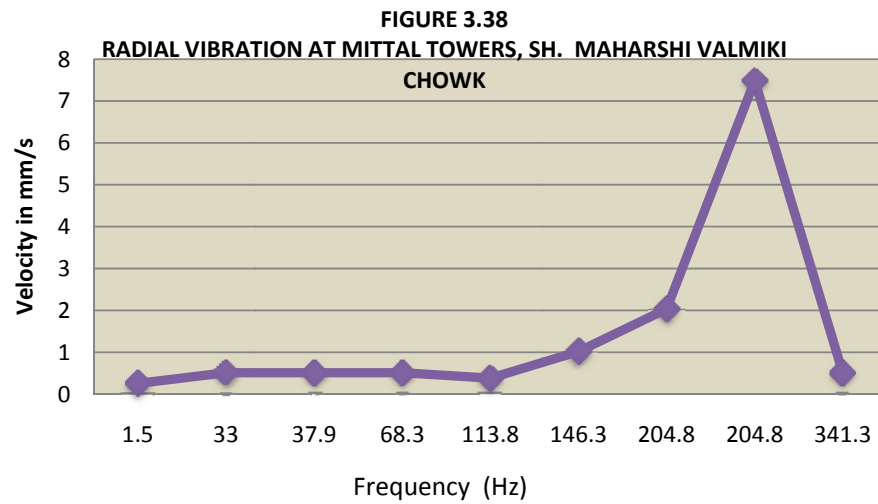
3.6.3 Vibration Monitoring at Location 3: Mittal Towers, Maharshi Valmiki Chowk.

The proposed metro line is passing through the Sh. Maharshi Valmiki chowk near to SBI building and opposite to Mittel towers. Here metro line is passing through the road in between Vidhan Sabha and State Bank of India building. The location is of tall buildings. The location of the monitoring is shown in **Figure 3.37**. The monitoring location falls at chainage no.1600.00 of proposed metro rail alignment. As per the field observation about 1500 vehicles per hour pass by this chowk that includes two, three and four wheelers.

FIGURE 3.37
VIBRATION MONITORING AT LOCATION AT MITTAL TOWERS



The graph of the radial vibration, transverse and vertical vibration has been plotted and shown in **Figure 3.38**, **Figure 3.39** & **Figure 3.40** respectively. The result of the monitoring shows that, the average vibration is below 2 mm/s which imply good condition. The average transverse vibration is found to be between 0.5 to 1 mm/s. The average vertical vibration of the study location is found to be below 2mm/s. During monitoring it was observed that there was a sudden rise in the vertical vibration of about 4 mm/ s at a frequency 0.1 Hz. This could be because of the vibration caused due to passing of heavy vehicle.



3.6.4 Vibration Monitoring at Location 4: Central Assurance Building, opp to Commissariat Building, Dr. Dadabhai Naoroji Road

The Central Assurance Building opposite to Commissariat Building at DN Road Mumbai is one of the oldest building and is also in the list of Heritage structures. The vibration monitoring was carried out in front of the building. The location of the monitoring is shown in **Figure 3.41**. The monitoring location falls at chainage no. 3280.00 of proposed metro alignment. As per the field observation about 4500 vehicles per hour pass by this road which includes two and four wheelers.

FIGURE 3.41
VIBRATION MONITORING AT LOCATION AT CENTRAL LIC BUILDING, DN ROAD



The graph of the radial vibration, transverse and vertical vibration has been plotted and shown in **Figure 3.42**, **Figure 3.43** & **Figure 3.44** respectively. The result of the monitoring shows that, the average vibration is below 1 mm/s which is quite normal vibration due to road traffic. The average transverse vibration is found to be between 1.4 to 1.6 mm/s. The average vertical vibration of the study location is found to be below 1mm/s.

FIGURE 3.42
RADIAL VIBRATION AT LIC BUILDING, DR. DADABHAI
NAOROJI ROAD

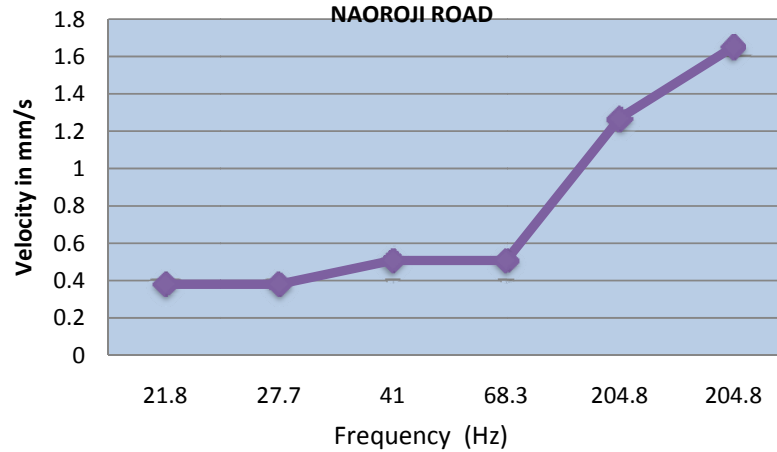


FIGURE 3.43
TANSVERSE VIBRATION AT LIC BUILDING, DR. DADABHAI
NAOROJI ROAD

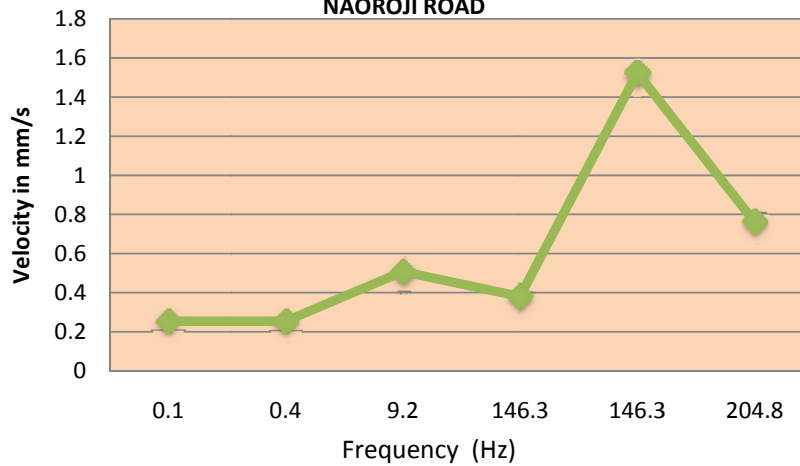
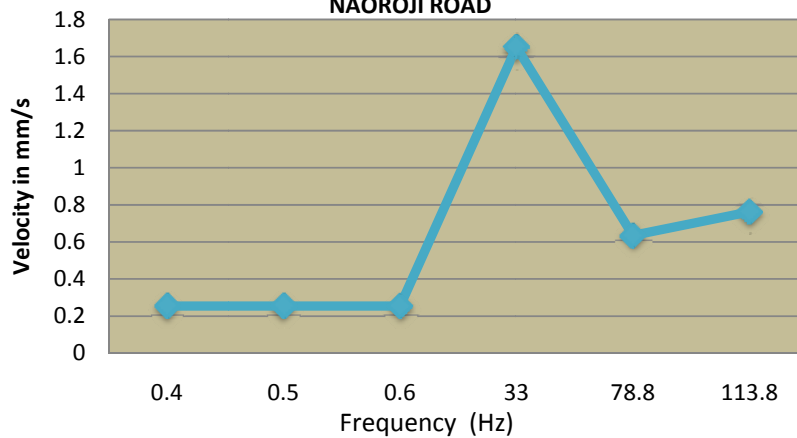


FIGURE 3.44
VERTICAL VIBRATION AT LIC BUILDING, DR. DADABHAI
NAOROJI ROAD



3.6.5 Vibration Monitoring at Location 5: Bhikha, Behram, Parsees Well, Hutatma Chowk.

Bhika Behram Well is a freshwater well dug in 1725 by a Parsi named Bhikaji who had come from Bharuch to Mumbai. The well has a perennial source of sweet water, which is remarkable as most of the water in the area is brackish owing to the proximity to the Arabian Sea. The vibration monitoring was carried out in front of Parsees well. The location of the monitoring is shown in **Figure 3.45**. The monitoring location falls at chainage no. 2700.00 of proposed metro alignment. As per the field observation about 4700 vehicles per hour pass by this chowk.

FIGURE 3.45
VIBRATION MONITORING AT LOCATION AT PARSEES WELL, HUTATMA CHOWK



The graph of the radial vibration, transverse and vertical vibration has been plotted and shown in **Figure 3.46**, **Figure 3.47** & **Figure 3.48** respectively. The result of the monitoring shows that, the average vibration is below 0.5 mm/s which are quite low vibration. The average transverse vibration is found to be between 0.3 to 0.4 mm/s. The vertical vibration shows the constant vibration all the time with 0.25 mm/s.

FIGURE 3.46
RADIAL VIBRATION AT PARSEES WELL, HUTATMA CHOWK

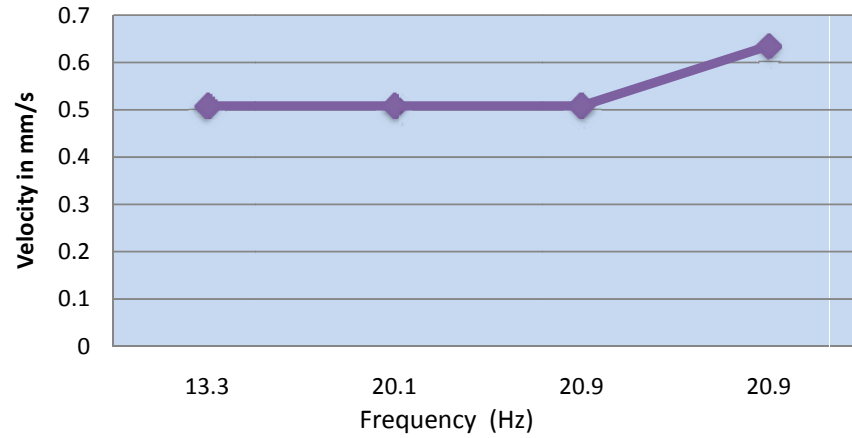


FIGURE 3.47
TRANSVERSE VIBRATION AT PARSEES WELL, HUTATMA CHOWK

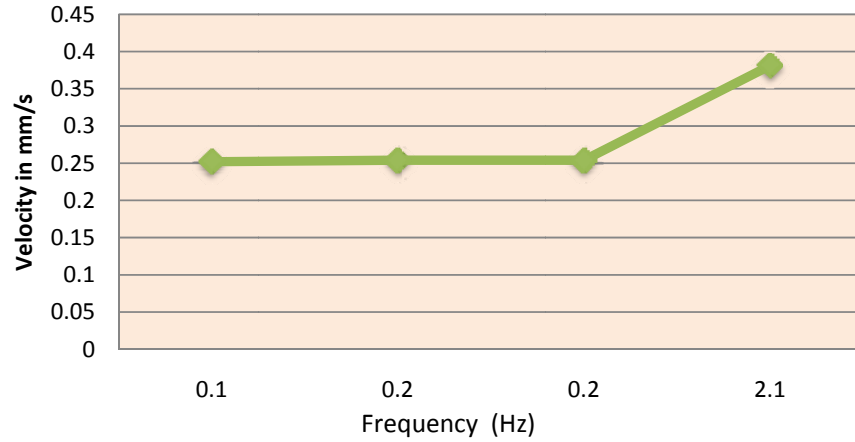
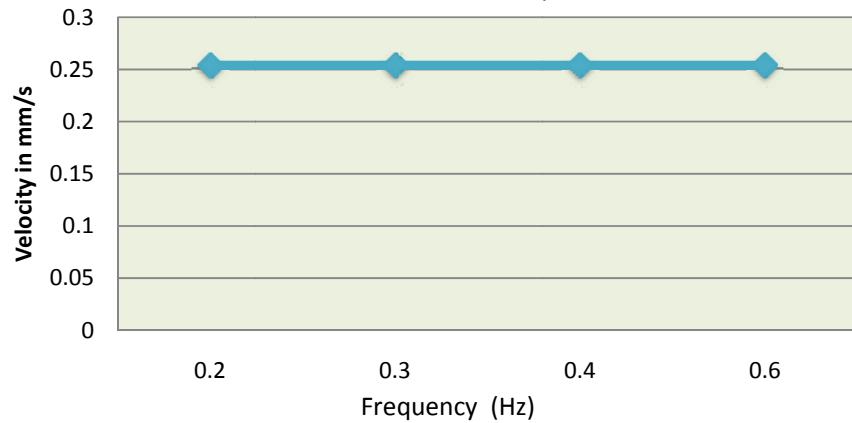


FIGURE 3.48
VERTICAL VIBRATION AT PARSEES WELL, HUTATMA CHOWK



3.6.6 Vibration Impact Assessment at Location 6: Chhatrapati Shivaji Terminus, Mumbai.

Chhatrapati Shivaji Terminus (Victoria Terminal) is one of the very renowned World Heritage structure in India which serves as the headquarters of the Central Railway. Chatrapati Shivaji Terminus building is more than 125 year old located at the heart of South Mumbai. The vibration modeling was carried out at Chatrapati Shivaji Terminus to assess the effect of vibration due to TBM and also to assess the impact on the CST structure due to running of underground metro train. The photograph of CST is given below. Based on the measured vibration of 5 locations along the corridor, the ambient vibration level for this location would be in the range of 110-126 VdB. Ambient vibration at this location will be measured prior to the start of construction work, as per the vibration monitoring program given in Table 8.6.

FIGURE 3.49
PHOTOGRAPHS SHOWING CHHATRAPATI SHIVAJI TERMINUS BUILDING



The impact of vibration due to TBM operation and train traffic has been predicted using GIS software on the satellite image of study location and using the Pipe-in-Pipe (PiP) model. The vibration analysis is presented in Chapter-4.

3.7 ECOLOGY

An ecological study of the project area is essential to understand the impact due to project development activities on flora and fauna of the area. The project site is located in city area and no wildlife is envisaged. To have a general understanding of the ecology within project area, brief information about flora and fauna of Mumbai is given below.

3.7.1 Forests/Flora

The forests cover in Mumbai city is 0.45 sq.km and Mumbai Suburban district 33.0 sq. km. which are entirely under the management of the Forest Department. These forests belongs to the National Park, Borivli, for the preservation of scenic, flotal, faunal, geological, historical and archaeological features in an unimpaired state for generations to come. In the National Park no silvicultural operations are carried out, and the exploitation as well as tending of the crop has been stopped. The important species found

in the Bombay forests are Teak, Khair (*Acacia Catechu*), Sisav (*Dalbergia latifolia*), Hed (*Adina* or *Nauclea Cordifolia*), Kalamb (*Stephegyne* or *Nauclea arivolia*) and Bamboo.

Trees survey was carried out along the proposed alignment and at station locations. The type of species observed is Gulmohar, Peepal, Coconut Palms, Sirus, Pilkhan and Neem. Approximately 589 trees have been observed along the project alignment at proposed station locations which are depicted in **Appendix-3.1**. About 1652 trees are observed at depot location at Aarey Milk Colony which are given in **Appendix-3.2**. Tree species are Gulmohar, Mango, Ber etc. No rare or endangered species of trees have been noticed during field studies.

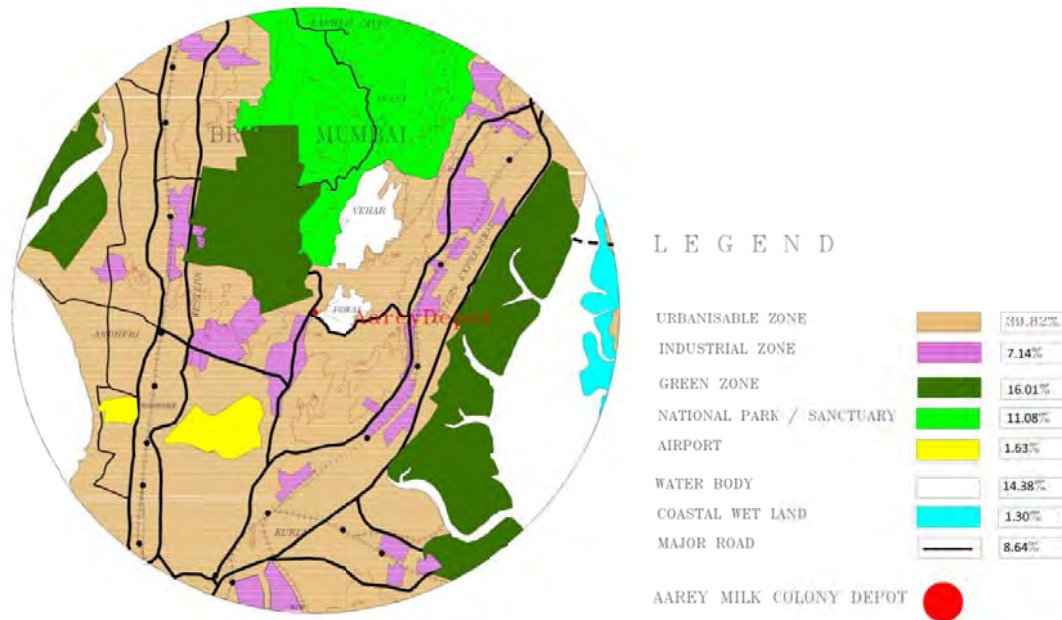
Since the project alignment corridor of metro train is passing underground at depth of about 20 m below ground level, hence no mangrove area are getting affected and no issue of CRZ are anticipated for the project.

3.7.2 Fauna

Mumbai is now so populous and overcrowded that it is no more a congenial home for wild animals. Greater Mumbai at present comprises mainly of residential and industrial areas. At present there is no forest in the true sense except the Borivli forest, extending over an area of about 19.18 sq. km. Hence, wild life as such is almost extinct from Mumbai. The fauna mainly consists of the common varieties of domesticated animals, such as, cows, oxen, buffaloes, sheeps, goats, pigs, donkeys, and mules. Wild life is now seen only within the National Park. The Tulsi and Vihar lakes are reported to provide a habitat to crocodiles and alligators. The vertebrate wild life of the Bombay Suburban District includes, besides a number of fishes, 42 species of mammals, 251 species of birds including migratory—land and water birds, 38 species of reptiles and species of amphibia. The wild life is characteristic of that part of west Coast of India which is north of Belgaum and south of Surat. The most abundant wild life encountered in Greater Mumbai at present consists of bird fauna. A variety of birds occur all over Mumbai city and suburbs, and particularly in the National Park, which are listed in **Appendix 3.3**. Mumbai is known as a fishing centre from the earliest days and fishing was one of the chief industries during the pre-British epoch. Not only did the harbour yield fish supply but also the estuaries, ponds and tanks on the island were exploited for fishing. The Kolis followed fishing as hereditary occupation and carried their operations from Colaba, Chaupati, Mazagaon, Worli, Sion, Mahim, Bandra, Trombay, Madh, Danda, Vesava, etc. The common species of fishes are Bombil (*Harpodon nehereus*), Mandeli (*Coilia dussumieri*), Kolambi (*Penacus* sp. *Actes* sp), Rawas (*Eleutheronema*) etc.

The depot has been planned at Aarey Milk Colony covering an area of 26.407 Ha. A landuse map has been prepared for study area of 10 km radius keeping depot site at centre is given in **Figure 3.50**.

FIGURE 3.50
LANDUSE PATTERN OF DEPOT



Sanjay Gandhi National Park, Borivalli is coming within the 10 km radius and at a distance of 1.65 km from centre of proposed depot. No wildlife has been observed at the project site. The location of Depot is shown in **Figure 3.51**.

FIGURE 3.51
LOCATION OF NATIONAL PARK

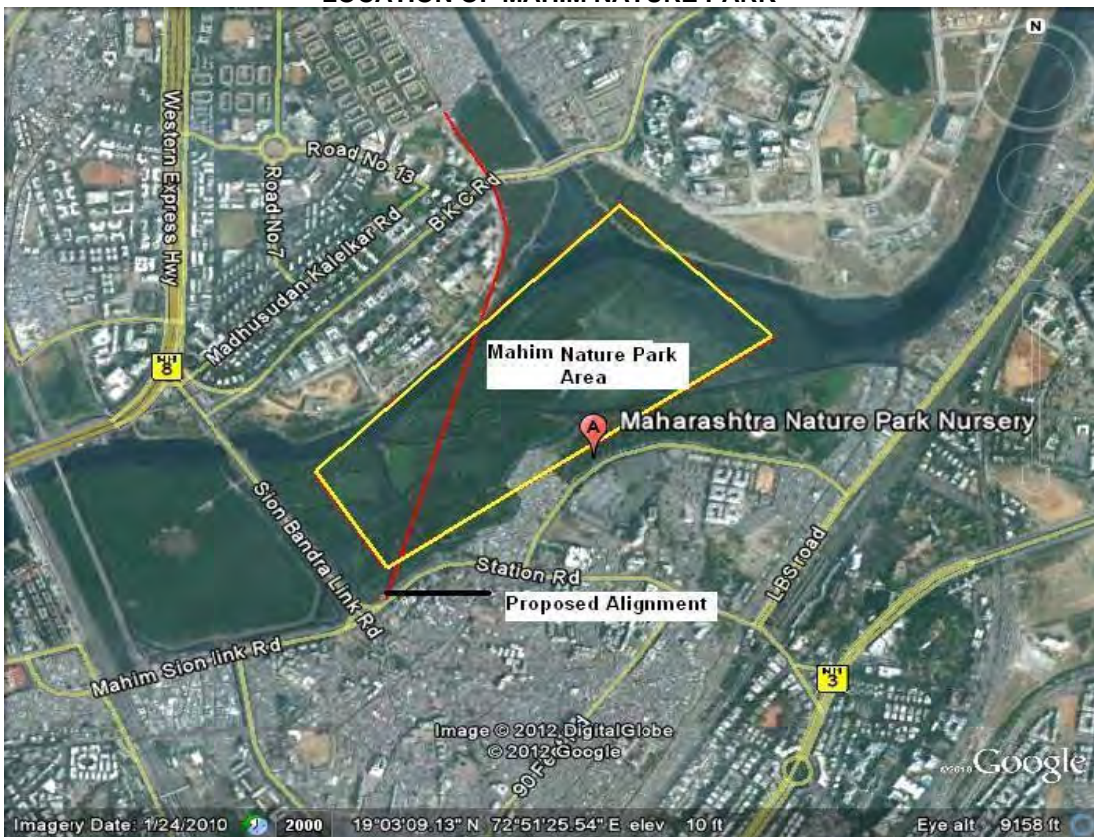


Biodiversity, Flora and Fauna of Sanjay Gandhi National Park

Sanjay Gandhi National Park is the house of 40 species of mammals, 251 of birds, land and water birds, 38 species of reptiles, 9 species of amphibians besides a large variety of fishes. The spectacular flowering of *Butea monosperma* (Flame of Forests) is a real feast to eye in the dry month of February to May. The national Park is a bird watcher paradise having Tickell's flower pecker (small bird in India), sun bird (humming birds), majestic white bellied sea eagle, the elusive Trogon and many species of Kingfishers, Woodpeckers, and Drongos. The variety of insects found in the park are Silk cotton bugs, Beetles and Mantis.

Mahim Nature Park: Located on the southern bank of Mithi river, and at Bandra-Sion Link Road close to Mahim Nature Park at Mahim. Here the proposed Metro alignment is passing underground. Earlier being the garbage dump, the place was conceived by WWF-India to be a nature park in 1976. MMRDA undertook the project to restore and develop the place as sophisticated nature park. The nature park is having the rich greenery with 200 species of trees. The location of Mahim Nature Park and the alignment of proposed metro are shown in the Google map as **Figure 3.52**.

FIGURE 3.52
LOCATION OF MAHIM NATURE PARK



3.8 SOCIO- ECONOMIC CONDITIONS

Development of proposed Mumbai Metro (Coloba-Bandra-SEEPZ) involves acquisition of land for stations, running sections, TSS, Depot and for other facilities. For different components of this corridor, out of total 45.81 hectare requirement of land, 4.72 hectare private land and 41.08 hectare government land shall be acquired. The detailed socio-economic assessment and resettlement action plan for the proposed project is being presented in separate report i.e., Social Impact Assessment for Mumbai Metro Corridor (Coloba-Bandra-SEEPZ).

3.9 HISTORICAL SITES

In 1972, the General Conference of UNESCO adopted a resolution with overwhelming enthusiasm creating thereby a 'Convention concerning the protection of the World Cultural and Natural Heritage'. The main objectives were to define the World Heritage in both cultural and natural aspects; to enlist Sites and Monuments from the member countries which are of exceptional interest and universal value, the protection of which is the concern of all mankind; and to promote co-operation among all Nations and people to contribute for the protection of these universal treasures intact for future generations.

India is an active member State on the World Heritage from 1977 and has been working in close co-operation with other International agencies like ICOMOS (International Council on Monuments and Sites), IUCN (International Union for the Conservation of Nature and Natural Resources) and ICCROM (International Centre for the study of Preservation and Restoration of Cultural Property).

The proposed alignment is passing closer to four historical monuments which is listed in the **Table 3.13**. Chhatrapati Shivaji Terminus (formerly Victoria Terminus) is the World Heritage Cultural Properties located at 40 m from the centre of the proposed metro alignment. Brihanmumbai Municipal Corporation Building located on Mahapalika Marg is declared as Historical Monuments and is 22 meter from the centre of the proposed metro alignment. The location of historical monuments and its distance from the centre of proposed alignment are shown in Google map as **Figure 3.53**, **Figure 3.54** and **Figure 3.55** respectively.

TABLE 3.13
HISTORICAL MONUMENTS WITHIN VICINITY OF ALIGNMENT

| SI | HISTORICAL MONUMENTS | DISTANCE FROM CENTRE OF METRO ALIGNMENT |
|----|------------------------------|---|
| 1 | CST Railway Station | 40 metre |
| 2 | BMC Building | 22 metre |
| 3 | Western Railway Head Quarter | 45 metre |
| 4 | Rajabhai Tower | 302 metre |

FIGURE 3.53
CST RAILWAY STATION & BMC BUILDING AT DN ROAD



FIGURE 3.54
WESTERN RAILWAY HEAD QUARTER ON JAMSHETJI TATA ROAD



FIGURE 3.55
LOCATION OF RAJABHAI CLOCK TOWER



3.10 SENSITIVE RECEPTOR

A drawing showing sensitive receptor like school, colleges, hospitals, place of worship, monuments/Statue structures etc. within 100 m on either side of metro is prepared and enclosed at last of the report in plastic pouch. The list of sensitive receptor is tabulated in **Table 3.14**.

TABLE 3.14
LIST OF SENSITIVE RECEPTORS

| SI | Description | Within 100 m on Either side |
|----|------------------|-----------------------------|
| 1 | School | 13 |
| 2 | Hospital | 22 |
| 3 | Temple | 21 |
| 4 | Mosque | 05 |
| 5 | Church | 06 |
| 6 | Monuments/Statue | 08 |
| | Total | 75 |

Appendix 3.1

TREES LIKELY TO BE AFFECTED DUE TO PROPOSED METRO ALIGNMENT

| SI No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | | |
|-------|-----------------|---------------|----------|---------|---------------------------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----|-----|--|
| | | | | | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 450 | 500 | |
| | | | | | - 30 | - 40 | - 50 | - 60 | - 70 | - 80 | - 90 | - 100 | - 120 | - 140 | - 160 | - 180 | - 200 | - 220 | - 240 | - 260 | - 280 | - 300 | - 350 | | | |
| 1 | Caffe parade | ST 1H | Gulmohar | 15 | | | | | | 1 | | | | | | | | | | | | | | | | |
| | | ST 1G | Peepal | 10 | | | | 3 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 15 | | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | peepal | 15 | | | | | | | 1 | | | | | | | | | | | | | | | |
| | | ST 1E | Gulmohar | 15 | | | | | 4 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 15 | | | | | | 1 | | | | | | | | | | | | | | | | |
| | | ST 1I | Ashoka | 10 | | | 1 | | | | | | | | | | | | | | | | | | | |
| | | TSS-1 | Sirus | 10 | | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Sirus | 10 | | | | | 2 | | | | | | | | | | | | | | | | | |
| | | | Peepal | 10 | | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 15 | | | | | | | | 1 | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Sirus | 10 | | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Sirus | 10 | | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Sirus | 10 | | | | 2 | | | | | | | | | | | | | | | | | | |
| | | | Sirus | 10 | | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | | 2 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | 2 | | | | | | | | | | | | | | | | | | |

| SI No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | | |
|-------|---------|---------------|----------|---------|---------------------------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----|-----|--|
| | | | | | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 450 | 500 | |
| | | | | | - 30 | - 40 | - 50 | - 60 | - 70 | - 80 | - 90 | - 100 | - 120 | - 140 | - 160 | - 180 | - 200 | - 220 | - 240 | - 260 | - 280 | - 300 | - 350 | | | |
| | | | Badam | 12 | | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Badam | 10 | | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Others | 8 | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | ST-1A | Others | 25 | | | | | | | | 1 | | | | | | | | | | | | | | |
| | | | Others | 8 | 2 | | | | | | | | | | | | | | | | | | | | | |
| | | | Others | 15 | | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Others | 10 | | 2 | | | | | | | | | | | | | | | | | | | | |
| | | | Others | 3 | 2 | | | | | | | | | | | | | | | | | | | | | |
| | | | Others | 12 | | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Others | 11 | | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Others | 10 | | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Others | 8 | | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Others | 5 | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | Others | 7 | | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Others | 10 | | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Others | 10 | | | | | | 1 | | | | | | | | | | | | | | | | |
| | | CD-1 | Gulmohar | 5 | | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Peepal | 5 | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | Peepal | 8 | | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Others | 8 | | | | | 1 | | | | | | | | | | | | | | | | | |
| | | CD-2 | Ber | 3 | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | Ber | 5 | | 1 | | | | | | | | | | | | | | | | | | | | |

| SI No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | | | | |
|-------|---------|---------------|----------|---------|---------------------------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----|-----|--|--|--|
| | | | | | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 450 | 500 | | | |
| | | | | | - 30 | - 40 | - 50 | - 60 | - 70 | - 80 | - 90 | - 100 | - 120 | - 140 | - 160 | - 180 | - 200 | - 220 | - 240 | - 260 | - 280 | - 300 | - 350 | | | | | |
| | | | Gulmohar | 5 | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| | | Platform | Gulmohar | 8 | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | Pilkhan | 15 | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | | 2 | | | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | | 2 | | | | | | | | | | | | | | | | | | | |
| | | | Others | 4 | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 4 | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| | | | Others | 3 | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | 2 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | 2 | | | | | | | | | | | | | | | | | | | | | |
| | | | peepal | 8 | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | Pilkhan | 8 | 3 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Pilkhan | 8 | | 1 | | | | | | | | | | | | | | | | | | | | | | |
| | | | Pilkhan | 10 | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| | | | Pilkhan | 10 | | | | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | | | | | | | 1 | | | | | | | | | | | | | |
| | | | Ashoka | 8 | | | | 2 | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 6 | | | | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | | | | | | | 1 | | | | | | | | | | | | | |

| Sl No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | |
|-------|---------|---------------|----------|---------|---------------------------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----|-----|
| | | | | | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 450 | 500 |
| | | | | | - 30 | - 40 | - 50 | - 60 | - 70 | - 80 | - 90 | - 100 | - 120 | - 140 | - 160 | - 180 | - 200 | - 220 | - 240 | - 260 | - 280 | - 300 | - 350 | | |
| | | | Peepal | 10 | | | | | | | 1 | | | | | | | | | | | | | | |
| | | | Pilkhan | 8 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Poplar | 4 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Peepal | 8 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | | | 1 | | | | | | | | | | | | | | |
| | | | Ashoka | 5 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 15 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 5 | 2 | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 5 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 8 | | | | | | | | | | | | | | | | | | 1 | | | |
| | | | Ashoka | 8 | | | 2 | | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 8 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 4 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | | 2 | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Karanj | 8 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Pilkhan | 15 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Gulmohar | 3 | 1 | | | | | | | | | | | | | | | | | | | | |

| SI No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | |
|----------|---------|---------------|----------|---------|---------------------------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----|-----|
| | | | | | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 450 | 500 |
| | | | | | - 30 | - 40 | - 50 | - 60 | - 70 | - 80 | - 90 | - 100 | - 120 | - 140 | - 160 | - 180 | - 200 | - 220 | - 240 | - 260 | - 280 | - 300 | - 350 | | |
| | | | Gulmohar | 8 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 5 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Neem | 5 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Badam | 5 | 2 | | | | | | | | | | | | | | | | | | | | |
| | | | Badam | 5 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Mango | 5 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Coconut | 1.5 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | 3 | | | | | | | | | | | | | | | | | | | | |
| | | | Pilkhan | 8 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Zial | 10 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | | | 1 | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Gulmohar | 7 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 6 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | | | 1 | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | | | | | 3 | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 12 | | | | | | | | | 7 | | | | | | | | | | | | |

| Sl No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | | |
|-------|------------------|---------------|----------------|---------|---------------------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----|-----|--|
| | | | | | 20 - 30 | 30 - 40 | 40 - 50 | 50 - 60 | 60 - 70 | 70 - 80 | 80 - 90 | 90 - 100 | 100 - 120 | 120 - 140 | 140 - 160 | 160 - 180 | 180 - 200 | 200 - 220 | 220 - 240 | 240 - 260 | 260 - 280 | 280 - 300 | 300 - 350 | 450 | 500 | |
| 2 | Bhadwa r Park | ST 2D | Badam | 5 | | 1 | | | | | | | | | | | | | | | | | | | | |
| | | ST 2C | Gulmohar | 10 | | | | 1 | | | | | | | | | | | | | | | | | | |
| | | ST 2H | Others | 10 | | 1 | | | | | | | | | | | | | | | | | | | | |
| | | ST 2I | Coconut | 10 | | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | ST-2F | Coconut | 10 | | | | 19 | | | | | | | | | | | | | | | | | | |
| | | | Karanj | 12 | | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Karanj | 8 | | | | | | 2 | | | | | | | | | | | | | | | | |
| | | | Garden Tree | 5 | | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Karanj | 10 | | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Garden Tree | 5 | | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Garden Tree | 5 | | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | 2 | | | | | | | | | | | | | | | | | | |
| | | | Garden Tree | 10 | | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Garden Tree | 15 | | | | | | | | | 1 | | | | | | | | | | | | | |
| | | | Garden Tree | 10 | | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Garden Tree | 10 | | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Pilkhan | 20 | | | | | | | | 1 | | | | | | | | | | | | | | |
| | | Platform | Coconut | 10 | | 25 | | | | | | | | | | | | | | | | | | | | |

| SI No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | |
|-------|---------|---------------|-----------------|---------|---------------------------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----|-----|
| | | | | | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 450 | 500 |
| | | | | | - 30 | - 40 | - 50 | - 60 | - 70 | - 80 | - 90 | - 100 | - 120 | - 140 | - 160 | - 180 | - 200 | - 220 | - 240 | - 260 | - 280 | - 300 | - 350 | | |
| | | | Bottle Brush | 5 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Coconut | 12 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Bottle Brush | 10 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Coconut | 10 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Garden Tree | 3 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Bottle Brush | 8 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Bottle Brush | 6 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Bottle Brush | 8 | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Badam | 5 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Coconut | 15 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Mango | 8 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | | | | | | | | 1 | | | | | | | | | | |
| | | | Badam | 12 | | | | | | | | | | | 1 | | | | | | | | | | |
| | | | Coconut | 10 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Gial | 10 | | | 2 | | | | | | | | | | | | | | | | | | |

| SI No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | | |
|-------|------------------|---------------|----------|----------|---------------------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----|-----|--|
| | | | | | 20 - 30 | 30 - 40 | 40 - 50 | 50 - 60 | 60 - 70 | 70 - 80 | 80 - 90 | 90 - 100 | 100 - 120 | 120 - 140 | 140 - 160 | 160 - 180 | 180 - 200 | 200 - 220 | 220 - 240 | 240 - 260 | 260 - 280 | 280 - 300 | 300 - 350 | 450 | 500 | |
| 3 | Vidhan Bhawan | ST 3E | Peepal | 20 | | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 20 | | | | | | | | 1 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | ST 3H | Coconut | 15 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | | Coconut | 10 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | | Gulmohar | 10 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | | Peepal | 15 | | | | | | | | | | | | | | | | 1 | | | | | |
| | | | | Other | 10 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | ST 3G | Gulmohar | 10 | | | | 2 | | | | | | | | | | | | | | | | | |
| | | | ST 3B | Peepal | 20 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | ST 3C | Gulmohar | 15 | | | | 7 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | Church Gate | ST 4B | Bargad | 15 | | | | | | | | | | | | | 1 | | | | | | | | | |
| | | | ST 4E | Bargad | 15 | | | | | | | | | | | | | | | | | 1 | | | | |
| | | | ST 4F | Umber | 10 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | ST 4H | Karanj | 10 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | | Peepal | 15 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | ST 4G | Peepal | 20 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | Hutatma | ST 5H | Gulmohar | 10 | | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | | Coconut | 20 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | | ST 5I | Peepal | 15 | | | | | | | | | | | 1 | | | | | | | | | |

| Sl No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | |
|-------|---------|---------------|----------|---------|---------------------------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----|-----|
| | | | | | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 450 | 500 |
| | | | | | - 30 | - 40 | - 50 | - 60 | - 70 | - 80 | - 90 | - 100 | - 120 | - 140 | - 160 | - 180 | - 200 | - 220 | - 240 | - 260 | - 280 | - 300 | - 350 | | |
| | | ST 5K | Peepal | 15 | | | | | | | | | | | 1 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | CST | ST 6E | Gulmohar | 15 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Gulmohar | 20 | | | | | | | | | | | | | 1 | | | | | | | | |
| | | ST CF&G | Ashoka | 10 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | ST 6H | Gulmohar | 15 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | Platform | Ashoka | 8 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 5 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 5 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 10 | | | | | | | 1 | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 10 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Ashoka | 15 | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | 2 | | | | | | | | | | | | | | | | |
| | | | Tamarind | 10 | | | | | | | 1 | | | | | | | | | | | | | | |
| | | | Pilkhan | 5 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | 2 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | 2 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 6 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | 2 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Pilkhan | 10 | | 1 | | | | | | | | | | | | | | | | | | | |

| Sl No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | |
|-------|-------------------|---------------|----------|---------|---------------------------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----|-----|
| | | | | | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 450 | 500 |
| | | | | | - 30 | - 40 | - 50 | - 60 | - 70 | - 80 | - 90 | - 100 | - 120 | - 140 | - 160 | - 180 | - 200 | - 220 | - 240 | - 260 | - 280 | - 300 | - 350 | | |
| | | | Peepal | 8 | | | | | | | | | | | | | | | | | | 1 | | | |
| | | | Gulmohar | 10 | | | | | | | | | | | | | | | | 1 | | | | | |
| | | | Badam | 5 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Peepal | 8 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Peepal | 10 | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | | | | | | | | | | | | | 1 | | | | | |
| | | | Gulmohar | 10 | | | | | | | | | | | | | | | | | | 1 | | | |
| | | | Gulmohar | 9 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | | | | | | | | | | | | | 1 | | | | | |
| | | | Gulmohar | 5 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Pilkhan | 10 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Peepal | 10 | | | | | 1 | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 3 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | 1 | | | | | | | | | | | | | | | | | | | | |
| 7 | Kalba Devi | | NIL | | | | | | | | | | | | | | | | | | | | | | |
| 8 | Girgaon | | NIL | | | | | | | | | | | | | | | | | | | | | | |
| 9 | Grant Road | ST 9D | Gulmohar | 15 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | ST 9F | Gulmohar | 15 | | | | | | 4 | | | | | | | | | | | | | | | |
| | | | Ashoka | 15 | | 1 | | | | | | | | | | | | | | | | | | | |
| 10 | Mumbai Central | ST 10I | Jamun | 25 | | | | | | | | | | | 1 | | | | | | | | | | |

| Sl No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | | | |
|-------|-------------------|---------------|----------|----------|---------------------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----|-----|--|--|
| | | | | | 20 - 30 | 30 - 40 | 40 - 50 | 50 - 60 | 60 - 70 | 70 - 80 | 80 - 90 | 90 - 100 | 100 - 120 | 120 - 140 | 140 - 160 | 160 - 180 | 180 - 200 | 200 - 220 | 220 - 240 | 240 - 260 | 260 - 280 | 280 - 300 | 300 - 350 | 450 | 500 | | |
| | | | Ashoka | 8 | | | | | | | | | | | 1 | | | | | | | | | | | | |
| | | | Coconut | 10 | | | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | Platform | Bargad | 10 | | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 4 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| | | | Badam | 5 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| 11 | Mahalax mi | ST 11E | Gulmohar | 10 | | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | ST 11F | Gulmohar | 10 | | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | Surus | 10 | | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | ST 11G | Peepal | 5 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | Science Museum | ST 12A | Ashoka | 10 | | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | ST 12D | Ashoka | 12 | | 2 | | | | | | | | | | | | | | | | | | | | | |
| | | ST 12F | Rubber | 12 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| | | | Coconut | 5 | | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | Other | 10 | | | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Mango | 15 | | | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Pilkhan | 15 | | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | ST 12G | Arhule | 5 | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | | Gulmohar | 10 | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | | ST 12E | Neem | 15 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Ashoka | 15 | | | | 2 | | | | | | | | | | | | | | | | | | | |

| SI No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | | |
|-------|---------------------------|---------------|-----------------|---------|---------------------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----|-----|--|
| | | | | | 20 - 30 | 30 - 40 | 40 - 50 | 50 - 60 | 60 - 70 | 70 - 80 | 80 - 90 | 90 - 100 | 100 - 120 | 120 - 140 | 140 - 160 | 160 - 180 | 180 - 200 | 200 - 220 | 220 - 240 | 240 - 260 | 260 - 280 | 280 - 300 | 300 - 350 | 450 | 500 | |
| | | | Badam | 15 | | | 1 | | | | | | | | | | | | | | | | | | | |
| | | ST 12C | Ashoka | 10 | | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Badam | 15 | | | | 1 | | | | | | | | | | | | | | | | | | |
| | | Platform | Bargad | 20 | | | | | | | | | | | | | | | | | | | | 1 | | |
| | | | Gulmohar | 10 | | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Pilkhan | 8 | | | | | | | | | 1 | | | | | | | | | | | | | |
| | | | Other | 8 | | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Peepal | 15 | | | | | | | | | | | | 1 | | | | | | | | | | |
| | | | Gulmohar | 20 | | | | | | | | 1 | | | | | | | | | | | | | | |
| | | | Pilkhan | 8 | | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 15 | | | | | | | | | | | | | | | | | | 1 | | | | |
| 13 | Acharya Atrey Chowk | ST 13B | Bottle Brush | 15 | | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Pilkhan | 10 | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | Peepal | 8 | 1 | | | | | | | | | | | | | | | | | | | | | |
| | | | ST 13E | Peepal | 10 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | ST 13A | Bhindi | 15 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | | Ashoka | 15 | | 4 | | | | | | | | | | | | | | | | | | | |
| | | | | Peepal | 15 | | | | | | 2 | | | | | | | | | | | | | | | |
| | | | | Peepal | 15 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Platform | Bargad | 10 | | | | | | | 1 | | | | | | | | | | | | | | |
| | | | | Poplar | 10 | | | | | | | | | 1 | | | | | | | | | | | | |
| | | | | Poplar | 8 | | | | | | | | 1 | | | | | | | | | | | | | |

| SI No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | |
|----------|---------|---------------|----------|---------|---------------------------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----|-----|
| | | | | | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 450 | 500 |
| | | | | | - 30 | - 40 | - 50 | - 60 | - 70 | - 80 | - 90 | - 100 | - 120 | - 140 | - 160 | - 180 | - 200 | - 220 | - 240 | - 260 | - 280 | - 300 | - 350 | | |
| | | | Rubber | 8 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Peepal | 10 | | | | | | | | | | 1 | | | | | | | | | | | |
| | | | Poplar | 8 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Guava | 3 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Jamun | 10 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Peepal | 10 | | | | | | | | | | | | | 1 | | | | | | | | |
| | | | Badam | 10 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Poplar | 8 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Peepal | 10 | | | | | | | | | | | 2 | | | | | | | | | | |
| | | | Badam | 8 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 15 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Peepal | 15 | | | | | | | | | | | | | 1 | | | | | | | | |
| | | | Coconut | 11 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Badam | 10 | | 2 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Poplar | 10 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Badam | 10 | | | | | | | 1 | | | | | | | | | | | | | | |
| | | | Mango | 10 | | | | | | | | | | | | | | | | | | | | | |
| | | | Coconut | 10 | | | 2 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Ashoka | 10 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Peepal | 10 | | | | | | | | 1 | | | | | | | | | | | | | |

| SI No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | |
|-------|---------|---------------|----------|---------|---------------------------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----|-----|
| | | | | | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 450 | 500 |
| | | | | | - 30 | - 40 | - 50 | - 60 | - 70 | - 80 | - 90 | - 100 | - 120 | - 140 | - 160 | - 180 | - 200 | - 220 | - 240 | - 260 | - 280 | - 300 | - 350 | | |
| | | | Gulmohar | 8 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Badam | 10 | | | | 2 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Sirus | 15 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Gulmohar | 15 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Jamun | 15 | | | | | | | 1 | | | | | | | | | | | | | | |
| | | | Mango | 15 | | | | | | | | | | | | | | | | | | | | | |
| | | | Pilkhan | 8 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Jamun | 10 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Badam | 4 | | 1 | | | | | | | | | | | | | | | | | | | |
| 14 | Worli | ST 14H | Neem | 15 | | | | | | 2 | | | | | | | | | | | | | | | |
| | | | Mango | 15 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 6 | 3 | | | | | | | | | | | | | | | | | | | | |
| | | ST 14I | Peepal | 15 | 2 | | | | | | | | | | | | | | | | | | | | |
| | | ST 14F | Jamun | 10 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | ST 14D | Gulmohar | 10 | | | 2 | | | | | | | | | | | | | | | | | | |
| | | ST 14G | Ashoka | 15 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | ST 14C | Badam | 20 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 20 | 1 | | | | | | | | | | | | | | | | | | | | |
| | | ST 14J | Gulmohar | 15 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 10 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | Platform | Gulmohar | 10 | | | 5 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | 1 | | | | | | | | | | | | | | | | | | | |

| SI No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | |
|-------|------------------|---------------|----------|----------|---------------------------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----|-----|
| | | | | | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 450 | 500 |
| | | | | | - 30 | - 40 | - 50 | - 60 | - 70 | - 80 | - 90 | - 100 | - 120 | - 140 | - 160 | - 180 | - 200 | - 220 | - 240 | - 260 | - 280 | - 300 | - 350 | | |
| | | | Gulmohar | 10 | | | | 2 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | | | 3 | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | | 4 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 15 | | | | 2 | | | | | | | | | | | | | | | | | |
| 15 | Sidhi Vinayak | | Gulmohar | 20 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 25 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Gulmohar | 20 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Badam | 10 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Palm | 15 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Bargad | 15 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Coconut | 15 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Gulmohar | 20 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Gulmohar | 20 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Coconut | 25 | | | | 3 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 25 | | | | | | | | | | | | | 1 | | | | | | | | |
| | | | Poplar | 15 | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Gulmohar | 15 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 15 | | | | | | | | 1 | | | | | | | | | | | | | |
| 16 | Dadar | ST 16C | Gulmohar | 20 | | | | | | 2 | | | | | | | | | | | | | | | |
| 17 | Shitla Devi | | Gulmohar | 15 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | ST 17D | Gulmohar | 10 | | | | | 1 | | | | | | | | | | | | | | | |
| | | | ST 17H | Gulmohar | 15 | | | | 1 | | | | | | | | | | | | | | | | |
| | | ST 17J | Gulmohar | 15 | | | | 1 | | | | | | | | | | | | | | | | | |

| Sl No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | | |
|-------|---------------|---------------|----------|---------|---------------------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----|-----|--|
| | | | | | 20 - 30 | 30 - 40 | 40 - 50 | 50 - 60 | 60 - 70 | 70 - 80 | 80 - 90 | 90 - 100 | 100 - 120 | 120 - 140 | 140 - 160 | 160 - 180 | 180 - 200 | 200 - 220 | 220 - 240 | 240 - 260 | 260 - 280 | 280 - 300 | 300 - 350 | 450 | 500 | |
| | | ST 17F | Gulmohar | 15 | | | 2 | | | | | | | | | | | | | | | | | | | |
| | | ST 17G | Gulmohar | 20 | | | | 1 | | | | | | | | | | | | | | | | | | |
| | | ST 17I | Other | 25 | | | | | | | | 1 | | | | | | | | | | | | | | |
| 18 | Dharavi | | NIL | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | Bandra | | Gulmohar | 8 | | | | | | | | 8 | | | | | | | | | | | | | | |
| | | | Peepal | 10 | | | | | | | 1 | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | | | | | | 2 | | | | | | | | | | | | | | |
| 20 | Mumbai Univ. | Platform | Gulmohar | 6 | | 36 | | | | | | | | | | | | | | | | | | | | |
| 21 | Santacruz | Platform | Bargad | 7 | | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Coconut | 10 | | | 2 | | | | | | | | | | | | | | | | | | | |
| | | | Peepal | 6 | | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Other | 5 | | 1 | | | | | | | | | | | | | | | | | | | | |
| 22 | CSIA Domestic | Platform | Gulmohar | 8 | | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Other | 6 | | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Other | 6 | | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Other | 7 | | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Coconut | 10 | | | 2 | | | | | | | | | | | | | | | | | | | |
| | | | Mango | 5 | | 1 | | | | | | | | | | | | | | | | | | | | |
| | | | Mango | 6 | | 1 | | | | | | | | | | | | | | | | | | | | |

| SI No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | |
|-------|--------------------|---------------|----------|---------|---------------------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----|-----|
| | | | | | 20 - 30 | 30 - 40 | 40 - 50 | 50 - 60 | 60 - 70 | 70 - 80 | 80 - 90 | 90 - 100 | 100 - 120 | 120 - 140 | 140 - 160 | 160 - 180 | 180 - 200 | 200 - 220 | 220 - 240 | 240 - 260 | 260 - 280 | 280 - 300 | 300 - 350 | 450 | 500 |
| 23 | Sahar Road | | Peepal | 10 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Peepal | 10 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 8 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 9 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 10 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 8 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Coconut | 10 | | 2 | | | | | | | | | | | | | | | | | | | |
| | | | Coconut | 8 | | | 2 | | | | | | | | | | | | | | | | | | |
| | | | Badam | 6 | | 1 | | | | | | | | | | | | | | | | | | | |
| 24 | CSIA International | | NIL | | | | | | | | | | | | | | | | | | | | | | |
| 25 | Marol Naka | | Coconut | 5 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Coconut | 10 | | | 3 | | | | | | | | | | | | | | | | | | |
| | | | Coconut | 10 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Coconut | 6 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Badam | 7 | | 2 | | | | | | | | | | | | | | | | | | | |
| | | | Badam | 7 | | | 1 | | | | | | | | | | | | | | | | | | |
| | | | Mango | 5 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Jamun | 9 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 10 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Neem | 6 | | 3 | | | | | | | | | | | | | | | | | | | |

| SI No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | |
|-------|---------|---------------|----------|---------|---------------------------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----|-----|
| | | | | | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 450 | 500 |
| | | | | | - 30 | - 40 | - 50 | - 60 | - 70 | - 80 | - 90 | - 100 | - 120 | - 140 | - 160 | - 180 | - 200 | - 220 | - 240 | - 260 | - 280 | - 300 | - 350 | | |
| 26 | MIDC | Platform | Mango | 15 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Kathal | 20 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 20 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Other | 10 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 20 | | | | | | | | 1 | | | | | | | | | | | | | |
| | | | Gulmohar | 20 | | | | | | | | | | | 2 | | | | | | | | | | |
| | | | Gulmohar | 20 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Jamun | 15 | | | | | | | 2 | | | | | | | | | | | | | | |
| | | | Coconut | 10 | | | 5 | | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 15 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Peepal | 20 | | 1 | | | | | | | | | | | | | | | | | | | |
| 27 | SEEPZ | ST 27C | BER | 15 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | BER | 15 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | Platform | Gulmohar | 20 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Badam | 10 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 5 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Neem | 20 | | | | | | | | 1 | | | | | | | | | | | | | |
| | | | Peepal | 20 | | | | | | | | | | | 1 | | | | | | | | | | |
| | | | Gulmohar | 20 | | | | | | | | 3 | | | | | | | | | | | | | |
| | | | Peepal | 15 | | | | | | | | 1 | | | | | | | | | | | | | |
| | | | Bargad | 25 | | | | | | | | | | | | | | | | | | | | | 1 |
| | | | Ashoka | 20 | | | | 6 | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 15 | | | | 3 | | | | | | | | | | | | | | | | | |
| | | | Ashoka | 20 | | | | 1 | | | | | | | | | | | | | | | | | |

| Sl No | Station | Compo nent | Species | Ht m | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | | |
|-------|---------|---------------|-----------------|---------|---------------------------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----|-----|
| | | | | | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 450 | 500 |
| | | | | | - 30 | - 40 | - 50 | - 60 | - 70 | - 80 | - 90 | - 100 | - 120 | - 140 | - 160 | - 180 | - 200 | - 220 | - 240 | - 260 | - 280 | - 300 | - 350 | | |
| | | | Other | 20 | | | | | | | | | | | 1 | | | | | | | | | | |
| | | | Peepal | 15 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 25 | | | | | | 4 | | | | | | | | | | | | | | | |
| | | | Engligh Imli | 25 | | | | | | | | | | | | 2 | | | | | | | | | |
| | | | Ber | 10 | | | | 1 | | | | | | | | | | | | | | | | | |
| | | | Gulmohar | 15 | | 1 | | | | | | | | | | | | | | | | | | | |
| | | | Palm | 30 | | | | 1 | | | | | | | | | | | | | | | | | |
| Total | | | | | 60 | 159 | 101 | 98 | 39 | 44 | 14 | 29 | 11 | 1 | 13 | 1 | 8 | 0 | 0 | 3 | 0 | 5 | 1 | 1 | 1 |

Appendix 3.2

TREES LIKELY TO BE AFFECTED DUE TO PROPOSED DEPOT AT AAREY MILK COLONY

| Depot | Species | Tree Girth in Centimetres | | | | | | | | | | | | | | | | | | | |
|--------------|-------------|---------------------------|-------|-------|-------|-------|-------|-------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| | | 20-30 | 30-40 | 40-50 | 50-60 | 60-70 | 70-80 | 80-90 | 90-100 | 100-120 | 120-140 | 140-160 | 160-180 | 180-200 | 200-220 | 220-240 | 240-260 | 260-280 | 280-300 | 300-350 | 400-450 |
| Arrey | Wild/Others | 179 | 92 | 135 | 76 | 44 | 98 | 9 | 60 | 17 | 3 | 19 | 7 | 14 | | 1 | 11 | | 6 | 1 | |
| | Gulmohar | 30 | 168 | 99 | 152 | 15 | 31 | 13 | 47 | 5 | | 18 | 7 | 11 | | 1 | 1 | | 2 | | |
| | Mango | 6 | 3 | 1 | 1 | | | | 2 | | 2 | 7 | 8 | 19 | 2 | 2 | 14 | | 2 | 2 | 1 |
| | Palm | | | | | | | 2 | | | 1 | 2 | | | | | | | | | |
| | Ber | 19 | 2 | 1 | 2 | 2 | | | | | | 2 | | 1 | | 1 | | | 1 | | |
| | Badam | | | | | | 1 | | | | | 1 | | | | | | | | | |
| | Palash | | | | | | | | | | | 2 | | | | | | | | | |
| | Peepal | | | | | | 1 | | 1 | | | 1 | | | | | | | 1 | 1 | |
| | Babool | | 1 | | | | | | | | | | | | | | | | | | |
| | Tamarime | | | | | | | 1 | 1 | | | | | 1 | | | | | | | |
| | Neem | | | | | | | | | | | 1 | | | | | | | | | |
| | Jackfruit | | | | | | | | | | | | | 1 | | | | | | | |
| Road Inside | Others | | | | | 3 | 2 | 1 | 1 | 1 | | 4 | 5 | 17 | 2 | 2 | 6 | 1 | 4 | | |
| | Gulmohar | | | | | 1 | 1 | | 5 | | | 2 | 4 | 10 | 1 | 3 | 2 | | 1 | 3 | 2 |
| | Mango | | | | | | | | | | | | | | | | 1 | | | | |
| Road Outside | Others | | | | | 1 | 6 | | | | | | 2 | 15 | 3 | | 3 | | 3 | | |
| | Gulmohar | | | | | | | 1 | 5 | 1 | | 2 | 6 | 15 | 1 | 2 | 3 | | 2 | | 1 |
| Total | | 234 | 266 | 236 | 231 | 66 | 140 | 27 | 122 | 24 | 6 | 61 | 39 | 104 | 9 | 12 | 41 | 1 | 22 | 7 | 4 |

Appendix 3.3

VARIETY OF BIRDS IN MUMBAI

- Red vented bulbul (*Molpastes cafercafer*);
- Red whiskered bulbul (*Old compsa joacosus fuscicandata*);
- Spotted babbler (*Pellorneum ruficeps*);
- Yellow eyed babbler (*Chrysomma, sinensis*);
- Indian tree pie (*Dendrocitta vagabunda vagabunda*);
- Indian shama (*Kittacinclla Malabarica malabarica*);
- Red breasted flycatcher (*siphiaparva subsp*);
- Black Dxongo (*Dicrurus macrocercus*);
- Racket tailed (*Discemurus paradisous malabaricus*);
- Tailor bird (*Orthotomus, sutorius guzeratd*);
- Indian oriole (*Oriolus oriolus, kundoo*);
- Common myna (*Acridotheres tristis tristis*);
- Commom babbler (*Argya candata candata*);
- White throated babbler (*Dumetia hyperythra*);
- Central Indian tora (*Egithina tiphinon humei*);
- Malabar gold fronted chloropise (*Chloropsis auripons frontalis*);
- Blue throat thrush (*Cyapro sybroia succica pallidogularis*);
- White throated ground thrush (*Ceokichla citrina cyamotus*);
- Blue rock thrush (*Monticola solitarius pandoo*);
- Paradise flycatcher (*Tehitrea paradisi paradisi*);
- White spotted fontail flycatcher (*Leucocirca Pectorlispectorlis*);
- Little minivet (*Pericrocotus perogrinus peregrinus*);
- Rupus-backed shrike (*Lanius sehach erythronotus*);
- Streaked fontail warbler (*Cisticola juncidis*);
- Black headed oriole (*Oriolus anthormus maderas patanus*);
- Common weaver-bird or Baya (*Plocens philippinus philippinus*);
- Ashy-crowned or black-bellied finch lark (*Eremoptenix grisea grised*);
- Loten's sun bird (*Cinnyris lotenid*);
- Purple sun bird (*Cinnyris asiatica asiaticd*);
- Indian pitta (*Pitta brachyws*);
- Southern yellow fronted pied woodpecker (*Dryobates mamattensis mamattensis*).

CHAPTER-4 NEGATIVE ENVIRONMENTAL IMPACTS

4.1 GENERAL

The primary function of an environmental impact assessment study is to predict and quantify the magnitude of impacts, evaluate and assess the importance of the identified changes and formulate plans to monitor and mitigate the actual changes. Environmental impacts could be positive or negative, direct or indirect, local, regional or global, reversible or irreversible. The process begins by identifying the development and operational activities resulting from the proposed project as contained in **Chapter-2** and **Chapter-3** is dedicated for providing information on the baseline environmental conditions for various parameters. This chapter discusses the potential impacts on environment. Attempts have been made to predict the impacts due to proposed project. The pollutants generated at the proposed project premises during construction and operation phases are solid, liquid and gaseous in nature. Pollutants may be generated continuously, periodically or accidentally. Sources of pollutants and their characteristics during the construction and operation phase are given in **Table 4.1**. This section identifies and appraises the negative impacts on various aspects of the environment likely to result from the proposed development.

- Land Environment,
- Water Environment,
- Air Environment,
- Noise Environment,
- Biological Environment and
- Socio-Economic Environment

The impacts on the above environmental components have been assessed during various phases of project cycle namely project Location, design, construction and operation.

4.2 IMPACTS DUE TO PROJECT LOCATION

During this phase, those impacts, which are likely to take place due to the layout of the project, have been assessed. These impacts are:

- Project Affected People (PAPs)
- Change of Land use;
- Loss of trees/forest;
- Utility/Drainage Problems, and
- Impact on Historical and Cultural Monuments
- Impact on Local Transport Facilities

4.2.1 Project Affected People (PAPs)

The proposed Mumbai metro rail project shall cause involuntary displacement of people along the alignment, which shall include both title holder and non-titled holder land owners. The issue of Rehabilitation and Resettlement (R&R) is addressed in a separate report.

4.2.2 Change of Land Use

Development of proposed Mumbai Metro Line III (Coloba-Bandra-SEEPZ) involves acquisition of land for stations, Depot, TSS, Cut & Cover station and for other facilities. For different components of this corridor, out of total 45.81 hectare requirement of land, 4.72 hectare private land and 41.08 hectare government land shall be acquired. The details of land requirement for different components of the project are given in **Table 4.1**. Acquisition of this private land may cause social disruption and economic loss for the project affected families/people. While implementing the project, there is a need to take into account these disturbances and losses due to the project, their impact on socio-economic condition of the people and plan for their mitigation measures to minimise any negative impacts. Considering the above, a sample Socio-Economic Survey (SES) was undertaken in order to assess the socio-economic condition of project-affected families/people and to examine the impacts of the proposed metro rail system on these conditions.

TABLE 4.1
LAND REQUIREMENT (Ha)

| S.NO | PARTICULARS | PERMANENT LAND REQUIREMENT | | TEMPORARY LAND REQUIREMENT | |
|--------------|---------------------|----------------------------|-------------|----------------------------|-------------|
| | | GOVERNMENT | PRIVATE | GOVERNMENT | PRIVATE |
| 1 | Depot | 26.407 | -- | - | - |
| 2 | Stations | 1.49 | 3.23 | - | - |
| 3 | TSS | 0.4 | 0.2 | - | - |
| 4 | Cut & Cover Station | - | - | 1.84 | 0.067 |
| 5 | Construction Depot | - | - | 10.95 | 1.23 |
| Total | | 28.297 | 3.43 | 12.79 | 1.29 |

Source: DPR

From the data it could be concluded that out of total permanent land requirement about 89.58 % land to be acquired is from Government and 10.42% from private sector. The compensation for land is included in Social Assessment Study Report of this study.

4.2.3 Loss of Trees/Forests

The proposed alignment of metro rail is in urban/ city area and will not pass through any forests. Hence no loss of forest is anticipated. The trees are getting affected only

at stations and at depot location since proposed alignment is underground. There are 589 trees observed along the alignment at station locations and 1652 trees are at depot (**Refer Section 3.7.1**). Hence the total number of trees likely to be affected is 2241. It is observed from the tree survey (Annexure 3.1), that 70% (i.e 1568) of the trees have girth below 1 metre which will be transplanted and remaining 30% (i.e 673) of the trees will be cut. With removal of these trees the process of CO₂ absorption, O₂ production and the income from forest products will get affected and the losses are reported in **TABLE 4.2**.

TABLE 4.2
OXYGEN DEFICIT DUE TO TREE LOSS

| S.NO. | DESCRIPTION | QUANTITY |
|-------|--|----------|
| 1. | Total no. of Trees to be cut | 673 |
| 2. | Increase in CO ₂ @ 21.8 Kg/year/ tree | 14672 kg |
| 3. | Decrease in Oxygen production @ 49 Kg/year/ tree | 32977 kg |

According to Clean Development Mechanism one tonne of CO₂ increase will yield one Carbon credit and 6 Euros (1Euro = Rs.69.00) is earned by one carbon credit. Total loss of carbon credit is 14.67 ton per year due to cutting of 673 trees. About 32977 kg of Oxygen production will get reduced because of tree loss and loss of Rs. 18.32 lakh (32977 (kg of O₂) X 55.55 (Rs./Kg of O₂) is anticipated.

4.2.4 Utility/Drainage Problems

There will have no impact on utility and drainage on the running section area as the proposed metro rail alignment is underground. But construction of metro station by cut and cover method will affect utilities and drainage of the area. The sub-surface, surface and overhead utility services may be sewer, water mains, storm water drains, telephone cables, electric lines, 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. Since these affect construction and project implementation time schedule/ costs for which necessary planning/ action needs to be initiated in advance.

4.2.5 Impact on Historical and Cultural Monuments

The proposed metro rail project will affect residential and commercial structures at some of the metro stations where construction be made by cut and cover method whereas no Archeological Monuments are likely to be affected. Some of the historical structures are close to the proposed metro alignment as depicted in Table 3.13. Chhatrapati Shivaji Terminus (formerly Victoria Terminus) is the World Heritage Cultural Properties located at 40 m from the centre of the proposed metro alignment. Brihanmumbai Municipal Corporation Building located on Mahapalika Marg is

declared as Historical Monuments and is 22 metre from the centre of the proposed metro alignment. Utmost care needs be taken so that no significant impact is anticipated on the historical structures due to project activities during construction and operation.

4.2.6 Impact on Local Transport Facilities

The metro rail has been proposed to cater the additional demand of present and future traffic requirement. Hence, no loss of job to the existing transport facilities is anticipated. The drivers of local transport facilities like buses, taxis, autos and rickshaws may be utilized to cater the requirement of transport from metro stations to work place and vice-versa. Additional employment opportunities are also anticipated due to the proposed metro.

4.3 IMPACTS DUE TO PROJECT DESIGN

Considered impacts, due to project designs are:

- Platform inlets and outlets,
- Ventilation and lighting,
- Metro station refuse, and
- Risk due to earthquake.

4.3.1 Platforms Inlets and Outlets

The platform level is about 13 m below for underground stations. The rail level of the corridor is about at a depth minimum of 15 m below the ground level/road level at station location and 18-20 m for mid sections. Wherever, the station proposed by NATM, the rail level is proposed minimum 20 m below the ground/ road level. With the increase in ridership, 8 coach trains are envisaged in future. To accommodate an increase in ridership, 27 m wide and 290 m long stations are proposed. Station design is planned for considering the growth in traffic demand beyond 2031. Hence the station layout accommodates the worst case scenario at each station. Also the station design is in compliance to the "Guidelines and space standards for barrier free built environment for disabled and elderly persons" published by the Ministry of Urban and Employment India in 1998.

The typical underground station is a two level station with platforms at the lower level and concourse on the upper level. Concourses are provided at the ends in such a manner that the total depth of the underground station and cost is kept to the minimum. Two emergency staircases are also being planned in the traffic islands.

Provision has been made for escalators to connect concourse to platforms. The escalators will be heavy duty "Public" service escalators capable of operating safely,

smoothly and continuously in either direction, for a period of not less than 20 hours per day, seven days per week within the environmental conditions. The escalators will be equipped with energy saving system with protection barriers. Also the design of the escalators will be such that they can be used as fixed staircases under a condition of power failure or activation by safety/protection devices. When the escalators are stationed, no slipping, jerking, sliding and vibration should occur. One lift has been provided on platform to provide access for elderly and disabled. Additional staircases have been provided for the fire escape at the two ends of platform. For emergency evacuation purposes, the maximum distance to an exit route on the platform shall be 50 metre.

Hence, it can be concluded that all stations have necessary provision for space at inlet, outlet, elevators and platforms to accommodate people in normal as well as in emergency situation. Hence no hazard is anticipated due to the proposed sizes of inlets and outlets.

4.3.2 Ventilation and Lighting

The underground stations of the corridors are built in a confined space. A large number of passengers occupy concourse halls and the platforms, especially at the peak hours. The platform and concourse areas have a limited access from outside and do not have natural ventilation. It is therefore, essential to provide forced ventilation in the stations and inside the tunnel for the purpose of supply of fresh air, preventing concentration of moisture, removing heat from battery, light fittings and air conditioning plant.

With the hot and humid ambient conditions of Mumbai during the summer and monsoon months, it is essential to maintain appropriate conditions in the underground stations in order to provide a “comfort-like” and pollution free environment. An overview of VAC systems in other metros like Jubilee line extension, Bangkok etc have similar climatic conditions and provide valuable information in deciding VAC concept.

The purpose of ventilation system is to provide pollution free comfort environment inside the tunnel (Underground station). Provision of ventilation system leads to air exhaust into the outside environment which has no significant impact on the environment.

In emergency situation, the tunnel ventilation system would be set to operate to control the movement of smoke and provide a smoke free path for evacuation of the passengers and for the fire fighting purposes. The proposed VAC system design has been guided by codes and standards like Subway Environment Design Handbook (SEDH), ASHRAE Handbook and NFPA-130, 2003 edition.

The platforms, concourse, staircase and escalator areas for underground stations will have adequate and uniform fluorescent lighting to provide pleasant and cheerful environment. The lighting system adopted in Delhi Metro will guide the design of this system. At Delhi Metro, Illumination adopted at different locations like at Entrance to stations, Booking/Concourse, Platforms, Passenger staircase and escalator areas, Offices and Tunnels are in the range of 100 to 250 LUX.

4.3.3 Metro Station Refuse

The collection and removal of refuse from railway stations in a sanitary manner is of great importance for effective vector control, nuisance abatement, aesthetic improvement and fire protection. The refuse from railway station includes;

- Garbage,
- Rubbish, and
- Floor Sweepings.

As per the available data from Delhi Metro Phase I and II, the solid waste generation is about 0.5-1.0 cum/day at underground stations. Thus about 20 cum of solid waste will be generated from all metro stations per day. The maintenance of adequate sanitary facilities for temporarily storing refuse on the premises is considered a responsibility of the MMRDA project authorities. The storage containers for this purpose need to be designed. However it is suggested that the capacity of these containers should not exceed 50 litres and these should be equipped with side handles to facilitate handling. To avoid odour and the accumulation of fly-supporting materials, garbage containers should be washed at frequent intervals.

4.3.4 Risk Due to Earthquake

The project area lies in Zone III of Bureau of Indian Standards (BIS) Seismic Zoning Map. Seismic factor proposed by India Meteorological Department (IMD) for the purpose of design of Civil Engineering structures shall be incorporated suitably while designing the structures.

4.4 IMPACT DUE TO PROJECT CONSTRUCTION

Although environmental hazards related to construction works are mostly of temporary nature, it does not mean that these should not be considered. Appropriate measures should be included in the work plan and budgeted for. The most likely negative impacts related to the construction works are: -

- Soil erosion,
- Traffic diversion and risk of existing building,
- Impact of proposed road improvement works,

- Problem of excavated soil disposal,
- Dust Generation,
- Increased water demand,
- Impact due to construction of Tunnel,
- Impact due to Land subsidence/Landslides,
- Impact due to Supply of Construction Material,
- Loss of Historical and Cultural Monuments,
- Impact due to Construction near Archeological Structures,
- Impact on Ground and Surface Water,
- Air Pollution,
- Noise Pollution,
- Impact due to Vibration,
- Health risk at construction site, and
- Impact on Sensitive Receptors

4.4.1 Soil Erosion,

Though the project may not have significant impact on soil erosion, however, minor impact on soil erosion due to runoff from unprotected excavated areas may result in soil erosion, especially when erodibility of soil is high. Mitigation measures include careful planning, timing of cut-and-fill operations and re-vegetation. Problems could arise from dumping of construction soils (concrete, bricks), waste materials (from contractor's camp) etc. causing surface and ground water pollution. Hence, it is proposed to have Ready Mix Concrete (RMC) directly from batching plant for use at site. Batching plants should be located away from the site preferably, away from the human settlements. The site of excavated earth/debris/muck & dumping of released construction materials would be identified suitably prior to start of the construction work.

The construction material such as steel, bricks, etc. will be housed in a fenced stored yard. The balance material from store yards will be removed for use/disposal at the end of work.

4.4.2 Traffic Diversions and Risk to Existing Buildings

During construction period, partial traffic diversions on road will be required, as most of the construction activities are for the entry and exit blocks on the edges of road. Most of the roads where alignment is passing are double lane. Hence, partial blocking of road only at the places wherever possible will be made, rather than completely blocking the roads. It will be advisable to make these roads as one way to allow for operation of traffic together with construction activities. Advance traffic updates/information on communication systems will be an advantage to users of affected roads. The rail corridor does not pose any serious risk to existing buildings

as the alignment is passing underground. Still it will be appropriate to carry out stability and ground settlement analysis for proceeding further during construction.

4.4.3 Impact of proposed road improvement works

The proposed metro rail alignment passes through areas where some projects are already under construction and some projects have been proposed for construction in future. During construction of the proposed metro rail project it is required for proper integration with other on-going and future projects. Area wise details of project under construction and future projects are given in **Table 4.3**.

TABLE 4.3
ON-GOING AND FUTURE PROJECTS

| AREA | PROJECT UNDER CONSTRUCTION | FUTURE PROJECTS |
|------------------------|-------------------------------|---|
| Dharavi | -- | Redevelopment plan |
| BKC-ITO | -- | Metro Line-II |
| Kalina | Widening of Sharada devi Raod | |
| Domestic Airport | -- | Construction of terminals/facilities as per Airport Master Plan |
| Sahar Road | IA Project Raod | Construction of terminals/facilities as per Airport Master Plan |
| International Terminal | IA Project Raod | Construction of terminals/facilities as per Airport Master Plan |
| Marol Naka | Metro Line-I | -- |
| Aarey Milk Colony | -- | Monorail Alignment on JVLR with integration station at Aarey Milk Colony(only if present metro gets terminated and mono rail comes) |

Schedule of construction of other road improvement works may be carefully seen prior to taking up of the construction of proposed metro corridor. EIA reports of the ongoing and future road improvement works should be collected by the developer for review to integrate the project activities of the proposed metro rail project. On the basis of review of impacts due to various activities of ongoing and future projects on the environment, suitable changes in the project schedule may be suggested during construction of the project. The above points will be taken care of by environmental engineer/Environmental expert of project developer.

4.4.4 Muck Disposal

The metro route is completely underground. The underground portion is 33.508 km. The construction activity involves tunnelling, cut and cover, foundation, fill and embankment. Owing to paucity of space in busy cities and for safety reasons,

elaborate measures need to be adopted for collection, storage, transfer and disposal of soil. All these activities will generate about 5.40 Mm³ of muck. On land disposal, 130 Ha of area will be required taking an average depth of filling as 4 metre. To avoid impact on land due to muck disposal, project proponent has identified five options for disposal of muck by utilizing the muck for various purposes as described in chapter-6.

4.4.5 Dust Generation

Protective measures shall be undertaken during construction phase for transportation of earth and establishment of the material due to use of heavy machinery like compactors, rollers, water tankers, and dumpers. This activity is machinery intensive resulting in dust generation. However, this activity will be only short-term. The total 5.40 Mm³ of muck has to be transported through trucks. The muck will be transported by trucks up to nearest proposed Jetty. The truck movement required for transporting the muck/ earth will be about 591 truck trips per day for the entire length. On an average a truck is anticipated to move about 100 km per trip. Hence total distance travelled would be 59,100 km per day. Being the good road condition in Mumbai, the dust generation due to transportation of muck will be insignificant.

4.4.6 Increased Water Demand

The water demand will increase during construction phase. Sufficient water for construction purpose is made available by digging borehole / borewell within the vicinity of the project site during the construction phase. Hence proper care shall be taken while deciding the location of these activities or drawing water from public facilities.

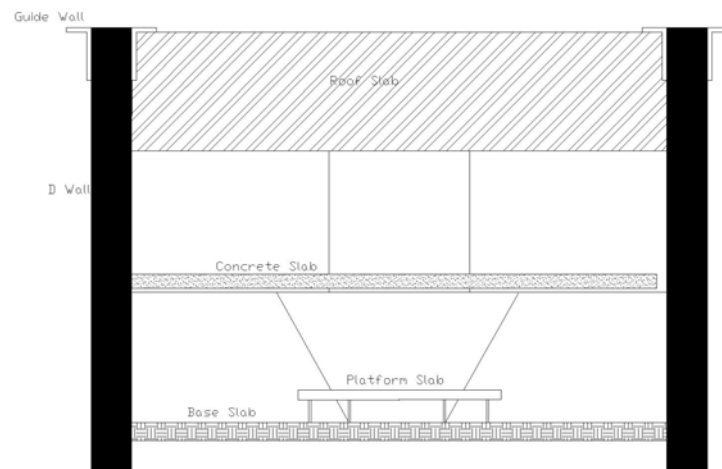
4.4.7 Impact due to Construction of Tunnel

Ground water contamination can take place only if chemical substances get leached by precipitation of water and percolate to the ground water table. This is not the case with the present project, as the activity does not use any harmful ingredients, which could leach down to water table. The tunneling is to be done in hard rock by Tunnel Boring Machine (TBM), which is widely used throughout the world. Therefore, no impact on ground water quality is anticipated from the project during the construction phase. The proposed project alignment is underground and tunneling will be done through hard rock hence no major impact on flow of water, surface and ground water quality is anticipated. However, care shall be taken that construction activities are not carried out during the monsoon period.

4.4.8 Impact due to Land Subsidence/Landslides

Land subsidence during construction of tunneling will not be anticipated as the whole alignment is passing through the hard rock base. It may be anticipated at the station locations where cut and cover method would be adopted. In a cut and cover method a trench is excavated with necessary ground support. The construction will be in situ concrete, precast concrete and corrugated steel. Use of permanent Diaphragm wall helps to maintain retention of the surrounding soil and ground water. The D-wall method is useful where ground water is high. Typical section of D-wall is shown below.

The tunnel is passing through Basaltic Granite strata hence no land slide is anticipated. However, state of the art technology like Tunnel Boring Machine (TBM), NATM etc will be adopted during construction to prevent the possible landslides.



4.4.9 Impact due to Supply of Construction Material

Metro construction is a material intensive activity. A summary of approximate construction material required for Phase III corridors is given in **Table 4.4**. Quarry operations are independently regulated activities and outside the purview of the project proponent. It is nonetheless, appropriate to give consideration to 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. About 10-15% of the construction material such as waste material from contractor camps is left behind by the contractor as construction waste/spoils. Dumping of construction waste/spoil in haphazard manner may cause surface and ground water pollution near the construction sites.

TABLE 4.4
CONSTRUCTION MATERIAL REQUIREMENT

| MATERIAL | UNIT | TOTAL QTY |
|----------------------------|----------------|------------------|
| Tunnel | | |
| Cement | MT | 51698 |
| Fly Ash | MT | 8363 |
| Sand | MT | 92818 |
| Aggregate 20mm | MT | 67504 |
| Aggregate 10mm | MT | 82513 |
| Silica | MT | 647 |
| Reinforcement | MT | 14735 |
| | | |
| Underground station | | |
| Cement | MT | 304846 |
| Fly Ash | MT | 110450 |
| Sand | MT | 669473 |
| Aggregate 20mm | MT | 651652 |
| Aggregate 10mm | MT | 485130 |
| Reinforcement | MT | 175876 |
| Stone Work | m ² | 255360 |
| MS Structure | Kg | 645120 |
| Stainless Steel | Kg | 926016 |
| Paint | Ltr | 161280 |
| Tiles Work | m ² | 45696 |

4.4.10 Loss of Historical and Cultural Monuments

No historical/cultural monuments will be lost as a result of the proposed development.

4.4.11 Impact due to Construction near Archaeological Structures

As per section 4.2.5 of the report, there is no Archeological Monuments near to proposed metro corridor; hence no impact is anticipated during construction. However the tunnel will be constructed by State of Art Technology i.e Tunnel Boring Machine (TBM) which gives negligible vibration and does not affect the surrounding structures. Stations/entry/exit area will be constructed by Cut and Cover method which is widely accepted and the safest technique being adopted by metro in India and abroad.

4.4.12 Impact on Ground and Surface Water

Insignificant impact will be anticipated on surface water as whole alignment is passing underground while ground water may get affected at the location where tunnel crosses the ground water flow. The availability of ground water aquifer in basaltic rock strata seems to be very rare and hence, breaking of water bearing strata is not anticipated. However, as a precautionary measure, detailed hydrological investigation will be undertaken prior to the construction of tunnel to locate the

ground water aquifer falling in the alignment of metro tunnel and to safeguard the ground water flow wherever feasible. This will prevent generation of turbid water during construction in the tunnel.

4.4.13 Air Pollution

Construction work of the metro rail has impact on the air quality at station and at depot only since metro alignment is constructed at an average depth of 18-20 metres. In the previous chapter, the existing conditions of air quality along the alignment are described. The monitoring results at some points show that while concentrations of some key pollutants such as NO₂, SO₂ and CO are much below the national standards (NAAQS, CPCB), the dust concentrations monitored are 2.0 – 2.4 times higher than the standard value. Hence, dust could be the problem when the project is under construction. Any development can have associated health impact that can result directly from changes to the biophysical environment or indirectly as the result of other changes caused by the project. The air pollutants such as particulate matter, sulphur dioxides and nitrogen oxide have adverse impact on human health. The impact of air pollution aggravates bronchitis, respiratory diseases, emphysema, cardiovascular diseases and eye irritation. However, the air pollution during construction is localized and only around the station construction sites only.

4.4.14 Noise Pollution

The major sources of noise pollution during construction are movement of vehicles for transportation of construction material and the construction machinery/equipment at the construction site. No major impacts are anticipated due to noise pollution as the major construction works are underground only. Noise levels at source have been forecasted at various distances as reproduced in **Table 4.5**. As seen from the table, construction activities are expected to produce noise levels in the range of 104 - 109 dB (A) at source which decreases with increase in distance.

**TABLE 4.5
FORECASTED NOISE LEVELS**

| S No | Machine | Noise Levels in dB(A) without Noise Controls | | |
|-------------|-------------------------------------|---|--------------------|----------------------|
| | | At Source** | At 50 feet* | At 150 feet** |
| 1 | 1.5 cum capacity Excavator / Loader | 109 | 85 | 65 |
| 2 | 8.33 cum capacity rear end dumper | 108 | 84 | 64 |
| 3 | Crawler Dozer | 109 | 85 | 65 |
| 4 | Heavy Duty jack Hammer | 109 | 85 | 65 |
| 5 | Compressor | 104 | 80 | 60 |
| 6 | Crane | 107 | 83 | 63 |
| 7 | Generator | 105 | 81 | 61 |
| 8 | Rock Drill | 122 | 98 | 78 |

* Data taken from "construction equipment noise levels and ranges report" of Federal Highway Administration, ** Calculated using logarithmic equation.

Exposure to noise may lead to complete hearing loss, tension, fatigue, fast pulse/respiration rates, dizziness & loss of balance, anger, irritation & in extreme case nervousness. Construction of noise barriers, such as temporary walls between noisy activities and receivers reduces noise by up to 15 dB(A). Vegetation cover also reduces the noise level.

Careful planning of machinery operation and scheduling of operations can however reduce the noise levels. The overall noise during construction will be for short-term (for day time only) and can be mitigated as mentioned in Chapter - 6.

4.4.15 Vibration Impact

The whole alignment of the Mumbai metro is underground and will be carried out by Tunnel Boring Machine (TBM). TBM is the worldwide accepted machine having less impact of vibration. Human response to ground-borne vibration is influenced by amplitude, duration and frequency and are subjective in nature. According to the U.S. Department of Transportation, (1998) the perception threshold of humans for particle velocity is about 0.04 mm/s (65 VdB with reference 1e-6 inch/sec). For a person in their residence, the lower threshold for annoyance is 72 VdB (FTA 2006). The vibration affects human health by causing fatigue, increased pulse & respiration rates, dizziness & loss of balance, anger and irritation.

4.4.15.1 Vibration due to Tunnel Boring Machine (TBM)

Ground borne noise caused due to tunneling can result in significant community annoyance. Ground borne noise from tunneling can also generate noise due to vibrations that are initiated by the cutting blades of tunneling equipment impacting the ground materials. Ground borne vibration caused by tunneling operations have the potential to cause significant community annoyance because, in general the operations are continuous for twenty four hours per day.

TBM typically consist of a large rotating cutting wheel in front of large metal cylinder(s) known as shields as well as trailing control and ancillary mechanisms. Behind the cutting wheel is a chamber where the spoil is removed using conveyors to the rear of the machine. The cutting wheel is moved forward by hydraulic jacks supported off the finished tunnel walls. When the cutting wheel has reached maximum extension the TBM head is braced against the tunnel walls and the rear section of the TBM is dragged forward.

Where vibrations are received by the building foundations, these are propagated other parts of the building. According to the U.S. Department of Transportation, (1998) the perception threshold of humans for particle velocity is about 0.04 mm/s (65VdB with reference 1e-6 inch/sec). Despite very low perception limit, most people will be annoyed by the ground-borne vibrations only if it has much higher levels. The ground-borne noise on the other hand may still be annoying even if the vibration

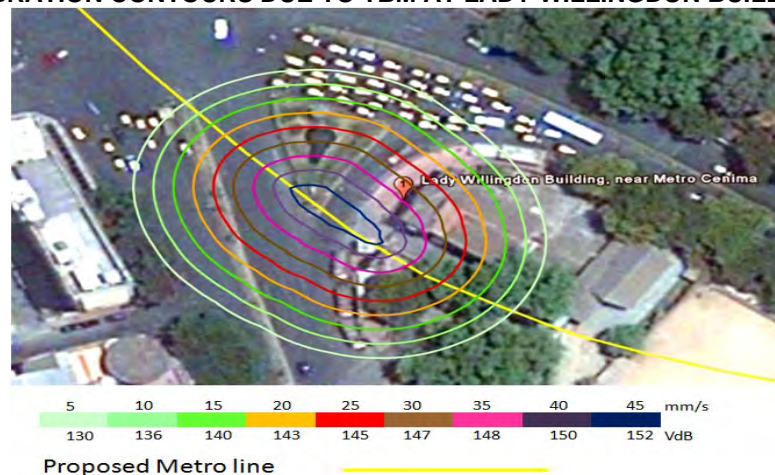
levels are below perception limits. Continuous effect of vibration on the buildings can cause damage to the buildings. Building subjected to the vibration effect with more than 50 mm/s would receive structural damage. Historic buildings are more susceptible to vibration effect due to type of building material and design. Old structures generally lose structure strength over the period. Therefore, it is more important to study the effect of vibration on the historic buildings especially the structures that comes under heritage category.

The vibration that could be generated due to TBM has been calculated at each monitoring location as presented in Chapter-3 using the standard equation. The diameter of the TBM blades was assumed to be 10 m with the operating speed of 1 m/ Hr. The TBM operation is considered at a depth of 18 m below ground level. As per the geotechnical report, the soil of the site is considered soft soil from 0 to 8m and beyond 8m, it is assumed to be hard bed rock. The vibration contours with contour interval of 5 mm/s were drawn using GIS software on the satellite image of study location. Vibration is generated at source from 18 m below the ground level and dissipates in all direction.

4.4.15.2 At the Lady Willingdon Building

The **Figure 4.1** shows the predicted vibration contours that could cause from TBM. The contour in the figure shows the vibration level on the ground surface. The predicted ground borne vibration due to TBM operation at this building is about 144 VdB. Geotechnical investigation is recommended at this location before going for TBM operation.

FIGURE 4.1
VIBRATION CONTOURS DUE TO TBM AT LADY WILLINGDON BUILDING

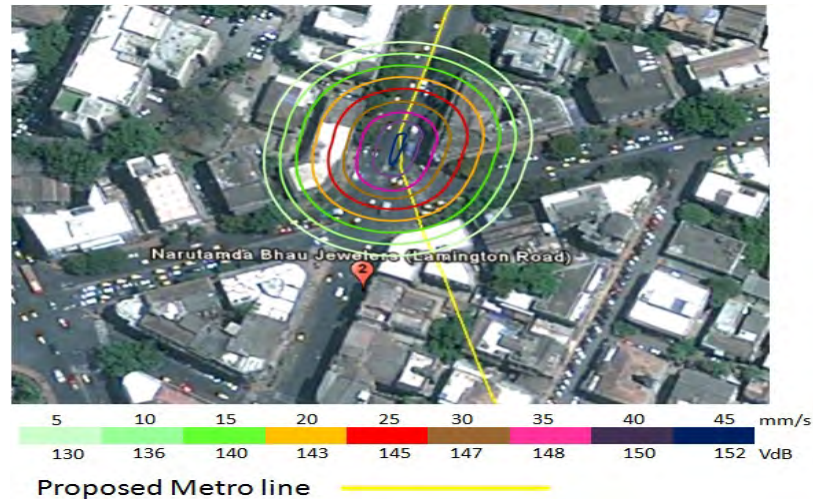


4.4.15.3 At the Narutamdas Bhau Jewelers, K.Gajanan Vertak Chowk, Lamington Road

The contour in the figure shows the vibration level on the ground surface. The **Figure 4.2** shows the predicted vibration contours that could cause from TBM. The predicted ground borne vibration due to TBM operation at closest building to road is about

147.8 VdB. Special care should be taken during the TBM operation at this location. Geotechnical investigation is recommended before going for TBM operation.

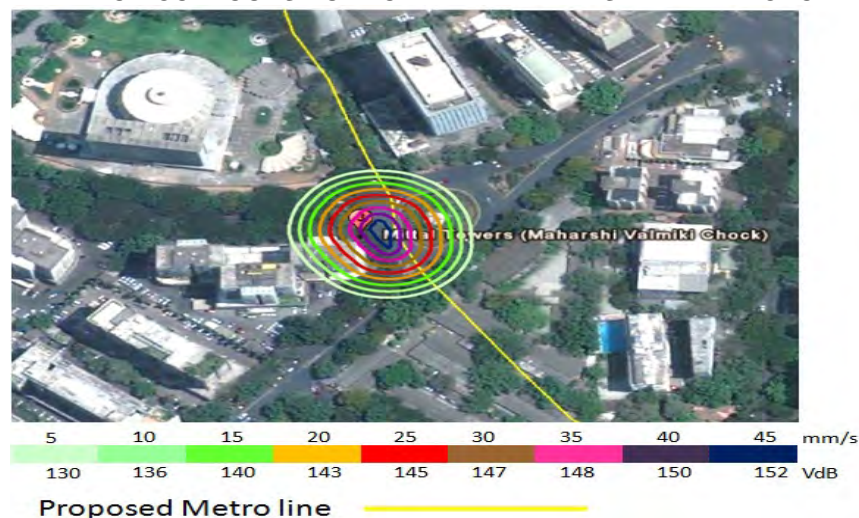
FIGURE 4.2
VIBRATION CONTOURS DUE TO TBM AT LAMINGTON ROAD MUMBAI



4.4.15.4 At Mittal Towers, Maharshi Valmiki Chowk

The **Figure 4.3** shows the predicted vibration contours that could cause from TBM. The predicted ground borne vibration due to TBM operation at closest building to road is about 143 VdB. Special care should be taken during the TBM operation at this location. Geotechnical investigation is recommended before going for TBM operation.

FIGURE 4.3
VIBRATION CONTOURS DUE TO TBM AT MAHARSHI VALMIKI CHOWK

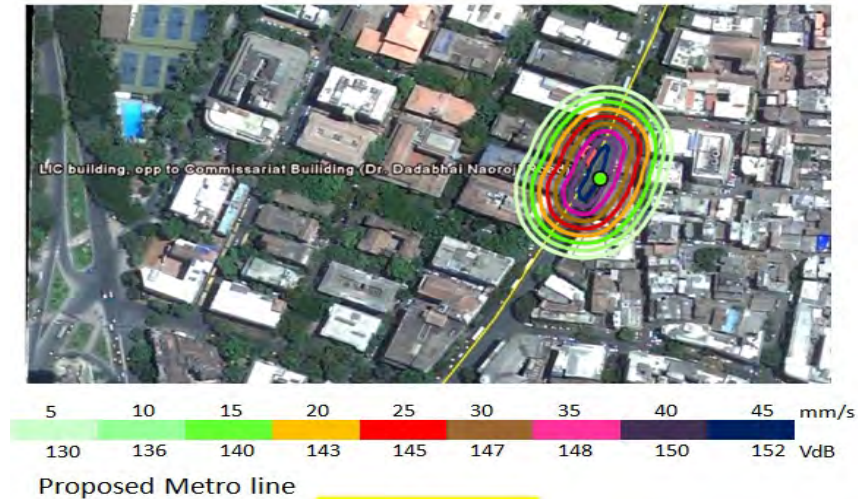


The contour shows that the vibration on the ground surface would be safe without affecting the nearby buildings. However a detailed vibration investigation is needed during TBM operation.

4.4.15.5 At Central Assurance Building, opp. to Commissariat Building

The vibration contours with contour interval of 5 mm/s were drawn using GIS software on the satellite image of study location. The **Figure 4.4** shows the predicted vibration contours that could cause from TBM. The predicted ground borne vibration due to TBM operation at closest building to road is about 147.8 VdB. Special care should be taken during the TBM operation at this location. Geotechnical investigation is recommended at this location before going for TBM operation.

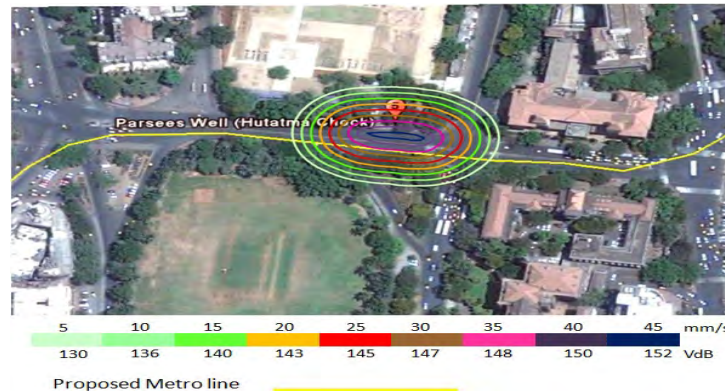
FIGURE 4.4
VIBRATION CONTOURS DUE TO TBM AT CENTRAL ASSURANCE BUILDING



4.4.15.6 At Bhikha, Behram, Parsees Well, Hutatma Chowk

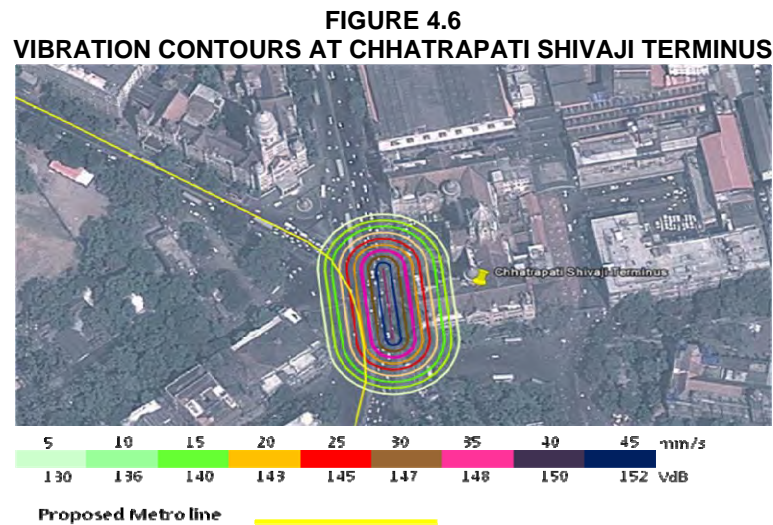
The **Figure 4.5** shows the predicted vibration contours that could cause from TBM. The contours show the vibration is high with 152 VdB at the center of road and at the Parsees well is around 145 VdB. During TBM operation it may effect the structure and the ground water level may go down due to disturbance in bedrock structure. The predicted ground borne vibration due to TBM operation at closest building to road is about 143 VdB. Special care should be taken during the TBM operation at this location. Geotechnical investigation is recommended at this location before going for TBM operation.

FIGURE 4.5
VIBRATION CONTOURS AT HUTATMA CHOWK



4.4.15.7 At Chhatrapati Shivaji Terminus

The **Figure 4.6** shows the predicted vibration contours that could cause from TBM. The contours show the vibration is about 147.3 VdB at closest building. Special care should be taken during the TBM operation at this location. Geotechnical investigation is recommended at this location before going for TBM operation.



4.4.16 Health risk at construction site

Health risks include accidents due to improper construction practice and hazard diseases due to lack of sanitation facilities (i.e., water supply and human waste disposal). Implementation of good construction practice may reduce the chance of accident at work place. Mitigation measures should include proper water supply, sanitation, drainage, health care and human waste disposal facilities at construction site. In addition to these, efforts need to be made to avoid water spills, adopting disease control measures, awareness programmes etc.

4.4.17 Impact on Sensitive Receptors

As discussed in section 3.9, there are 75 numbers of sensitive receptors identified within 100 m on either side of the alignment. The nearest receptor is 40 metre away from the centre line of metro alignment. Impacts on the sensitive receptors are likely to be during construction period and only at station locations. The major impacts to the sensitive receptors are due to noise and vibration.

The major sources of noise pollution during construction activities would be during excavation, loading, transportation of materials and operation of construction equipments and DG sets etc. Expected noise levels due to use of construction machineries at site are forecasted w.r.t distance which may be referred in Table 4.5.

Construction activities have the potential to produce vibration levels that may be annoying or disturbing to humans living nearby. Blasting below the surface would produce lower vibration levels at a receptor due to additional attenuation provided by distance and transmission through soil and rock. Federal Transit Administration (FTA) has recommended the typical levels of vibration for construction equipment which are summarized in **Table 4.6**. In the table the values at 25 feet are based on the FTA 1995. On the basis of reference values of vibration at 25 feet, an impact at 75 feet, 100 feet and 150 feet are calculated. The ground borne vibration impacts may be somewhat perceptible to people who are outdoors, it is almost never annoying and does not cause a strong adverse human reaction. According to the California Department of Transportation, (2004), the threshold of perception, or roughly 0.25 mm/s (108 VdB) may be considered annoying to people and the architectural damage criterion for continuous vibrations is 5 mm/s (134 VdB).

TABLE 4.6
TYPICAL LEVELS OF VIBRATION FOR CONSTRUCTION EQUIPMENTS

| Sl | Construction Activity | VdB at 25 Feet | VdB at 75 Feet | VdB at 100 Feet | VdB PPV at 150 Feet |
|----|-----------------------|----------------|----------------|-----------------|---------------------|
| 1 | Rock drilling | 115.9 | 101.6 | 97.9 | 94.3 |
| 2 | Dump trucks | 122.7 | 108.3 | 104.6 | 99.3 |
| 3 | Bulldozer | 124.0 | 109.7 | 106.0 | 100.7 |
| 4 | Excavator 0.089, 106 | 124.0 | 109.7 | 106.0 | 100.7 |
| 5 | Crane 0.808, 87 | 143.2 | 128.9 | 125.1 | 119.8 |

Source: Transit Noise and Vibration Impact Assessment, Federal Transit Administration (FTA).

4.4.18 Impact due to Labour Camp

Skilled labours associated with tunneling and fabrication work are supposed to stay at labour camp while the local labour will be employed for other associated work like earthwork and concreting. About 250 skilled labour will stay at labour camp. Three labour camps will be proposed at appropriate and suitable locations. Considering that 80% of labourers are married, in 80% of married families both husband and wife will be working and taking average family size as 4, total workforce in the labour camps will be about 450. The water requirement at camp will be 31.5 KLD, waste water generation 25.2 KLD & Municipal solid waste generation 157.5 Kg per day. Construction workers are more prone to infectious diseases like HIV/AIDS due to migration and lack of education. The three main transmission routes of HIV are sexual contact, exposure to infected body fluids or tissues and from mother to foetus or child during prenatal period. Training and awareness programme will be conducted during construction to avoid the spread of infected diseases and maintain good sanitation in labour camp.

4.5 IMPACTS DUE TO PROJECT OPERATION

Along with many positive impacts, (Refer **Chapter 5**) the project may cause the following negative impacts during operation of the project due to increase in the number of passengers and trains at the stations:

- Noise pollution,
- Vibration Impact due to train,
- Water supply and sanitation at Stations,
- Refuse disposal and sanitation, and
- Electromagnetic Interference

4.5.1 Noise Pollution

During the operation phase the main source of noise will be from running of metro trains. Noise radiated from train operations and track structures generally constitute the major noise sources. The main sources of noise from the operation of trains include: engine noise, cooling fan noise, wheel-rail interaction, electric generator and miscellaneous noise like passenger's chatting.

US data shows that the noise levels inside the rail transit cars range from about 65 to 105 dB(A) during normal operation but it will depend on various factors like Train speed, type of way structure, sound insulations of car body, type & design of mechanical equipment, wheel and rail conditions. A study was also carried out by National Physical Laboratory for Delhi metro noise levels in elevated and underground metro stations for various operations. The Noise Level at 15 m from track Centre Line and at 25 km/h is 75.0 ± 10.0 while interior noise level is about 78.0 ± 8.0 . The noise generated due to metro is limited within the tunnel area and station and hence users only have impact of noise during operation.

4.5.2 Vibration Impact due to train

The prediction of vibration was computed using the Pipe-in-Pipe (PiP) model using train traffic. PiP model has been developed by the team of experts and scientist from Nottingham University, UK. It is commonly used to simulate the vibration that is generated in the tunnel due to train passage. The vibration is calculated in Power Spectral Density. The prediction of vibration due to train passing is simulated and the results are shown in Power Spectral Density (PSD). The figures plotted shows the assumptions made for the prediction of vibrations. The velocity of the train is considered as 40 km/hr at all locations. The vibration contours were plotted which gives the clear picture of the vibration effect. Due to limitation in the available modeling tools, the vibration simulation was carried out with single train passby, however there would be increase in vibration when two trains are in tunnel. The increase would be up to 3 VdB. The Power Spectral Density graph plotted in Figure 4.7, 4.9, 4.11, 4.13, 4.15 & 4.17 are used to calculate the vibration at 6 locations during operation. The calculations are based on the input data as per site condition and operation of metro train. The maximum vibration is observed due to metro train in the frequency range of 0 Hz to 80 Hz, hence this range has been selected for prediction. Figure 4.8, 4.10, 4.12, 4.14, 4.16 & 4.18 represent the vibration contours for Case-1(80 Hz) and Case-2 (10 Hz). Case-1 and Case-2 are contours based on

maximum and minimum frequencies only for visualization of vibration effect. These figures cannot be considered for calculation purpose.

4.5.2.1 At Lady Willingdon Building.

The result of the vibration prediction using PiP model is shown in **Figure 4.7**. The graph shows that the vertical Power Spectral Density (PSD) is rising with the frequency and has become constant at 92 PSD (VdB). The **Figure 4.8** shows the clear pattern of vibration effect due to train passage at Dhobi Talao location. It can be seen that the vibration is high at the bottom portion of the track. The ground borne vibration at the surface would be 85-90 PSD (VdB), which do not have much effect on the surrounding buildings during operation.

FIGURE 4.7
VIBRATION DUE TO TRAIN AT LADY WILLINGDON BUILDING USING PiP

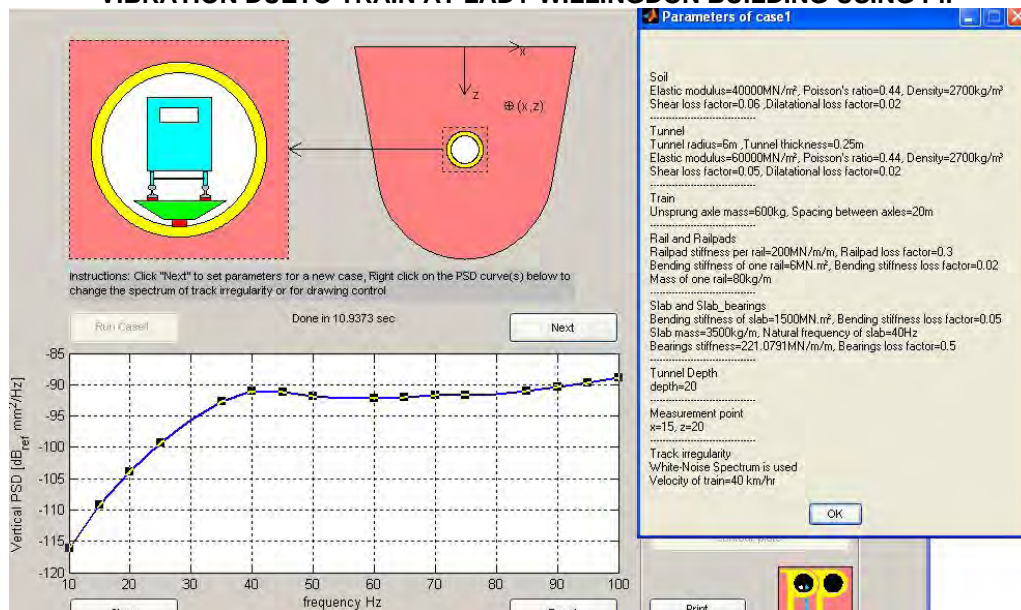
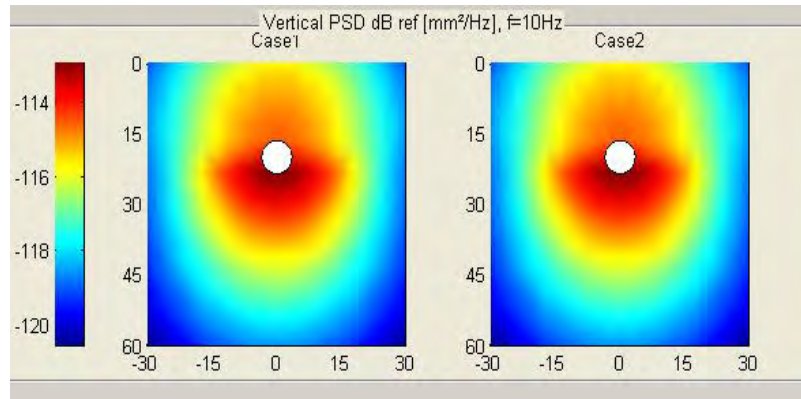


FIGURE 4.8
PREDICTED VIBRATION CONTOURS AT DHOBI TALAO LOCATION USING PSD



4.5.2.2 At K.Gajanan Vertak Chowk, Lamington Road Mumbai.

The result of the vibration prediction using PiP model is shown in **Figure 4.9**. The graph shows that the vertical Power Spectral Density (PSD) is low from 10 to 20 Hz frequency after that is found rising. The peak vibration is 72 PSD (VdB). The vibration contour map is shown in **Figure 4.10**. The contour map shows vibration is high at bottom portion of the track. The ground borne vibration at the surface would be 75 PSD (VdB), which do not have much effect on the surrounding buildings during operation of metro rail. The predicted vertical vibration at this location shows between 70 to 75 VdB.

FIGURE 4.9
VIBRATION DUE TO TRAIN AT K.GAJANAN VERTAK CHOWK, LAMINGTON ROAD MUMBAI USING PiP

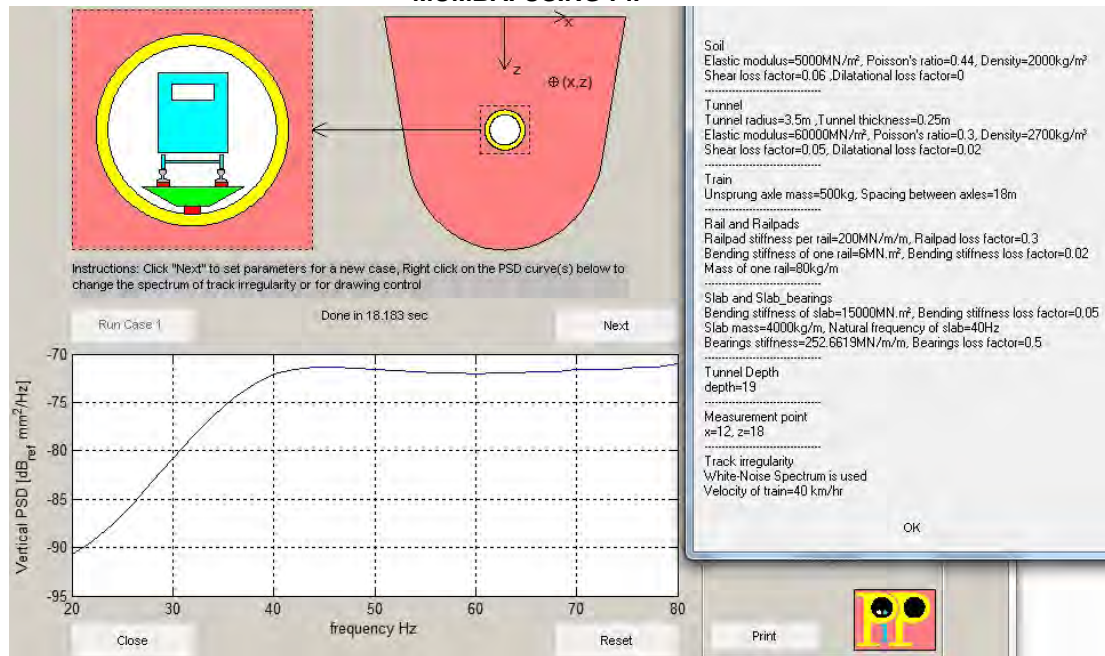
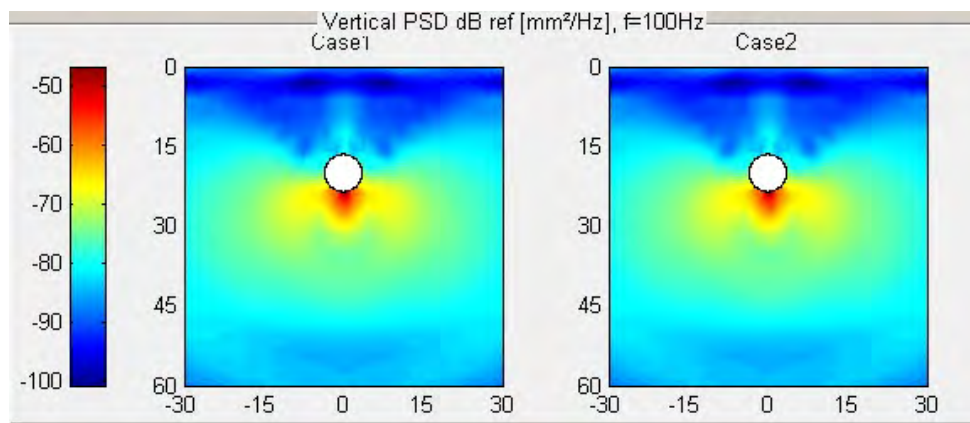


FIGURE 4.10
VIBRATION CONTOURS AT K.GAJANAN VERTAK CHOWK, LAMINGTON ROAD MUMBAI USING PSD



4.5.2.3 At Mittal Towers, Maharshi Valmiki Chowk.

The result of the vibration prediction using PiP model is shown in **Figure 4.11**. The graph shows that the vertical Power Spectral Density (PSD) is high at the frequency 40 Hz and is constant between 65 to 75 PSD (VdB). The vibration contour maps are shown in **Figure 4.12**. The figure 4.12 shows the clear pattern of vibration effect due to train passage. It can be seen that the vibration is high at the bottom portion of the track. The ground borne vibration at the surface would be 120 PSD (VdB), which do not have much effect on the surrounding buildings during metro operation.

The predicted vertical vibration due to metro rail passby at this location shows between 65 to 70 VdB. However the predicted results are within the limits, a detailed vibration analysis is required to be monitored on the top of the tall building.

FIGURE 4.11
VIBRATION DUE TO TRAIN AT MITTAL TOWERS, MAHARSHI VALMIKI CHOWK USING PiP.

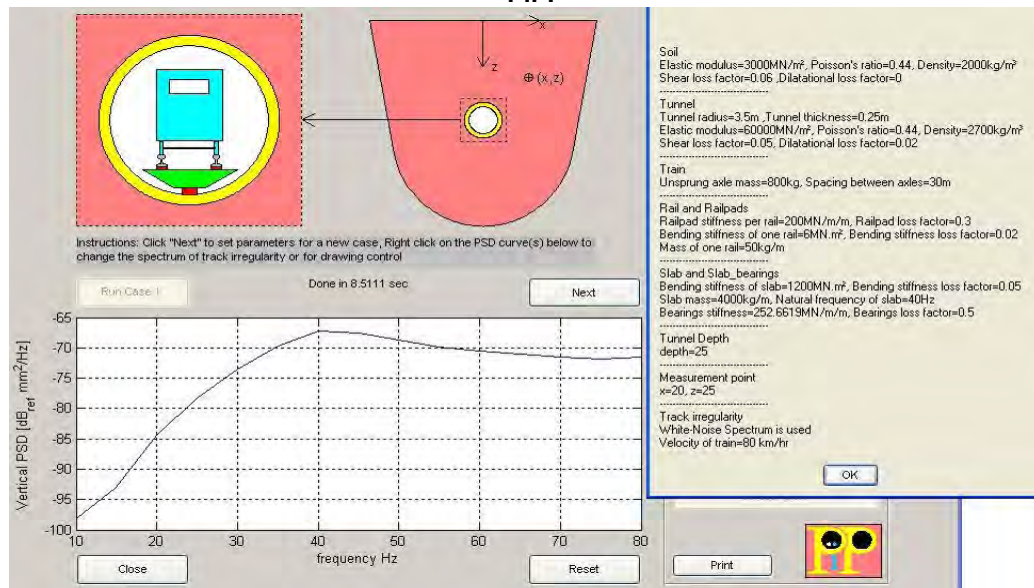
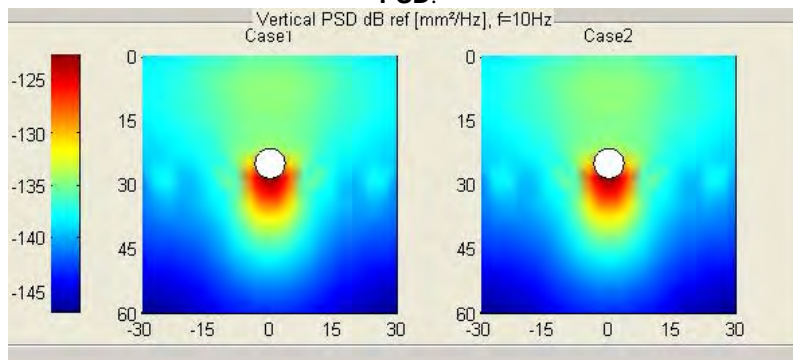


FIGURE 4.12
VIBRATION CONTOURS AT MITTAL TOWERS, MAHARSHI VALMIKI CHOWK USING PSD.



4.5.2.4 At Central Assurance Building, Opp. to Commissariat Building Mumbai.

The result of the vibration prediction using PiP model is shown in **Figure 4.13**. The graph shows that the vertical Power Spectral Density (PSD) is more at the frequency 40 Hz. The vibration contour maps are shown in **Figure 4.14**. It can be seen that the vibration is high at the bottom portion of the track. The ground borne vibration at the surface would be 80PSD (VdB), which do not have much effect on the surrounding buildings during operation.

The predicted vertical vibration due to metro rail passby at this location shows between 65 to 70 VdB. Many building at the road comes under heritage category. Special care should be taken at the time of construction of tunnel and also during metro rail operation.

FIGURE 4.13
VIBRATION DUE TO TRAIN AT CENTRAL ASSURANCE BUILDING, OPP. TO
COMMISSARIAT BUILDING MUMBAI USING PiP

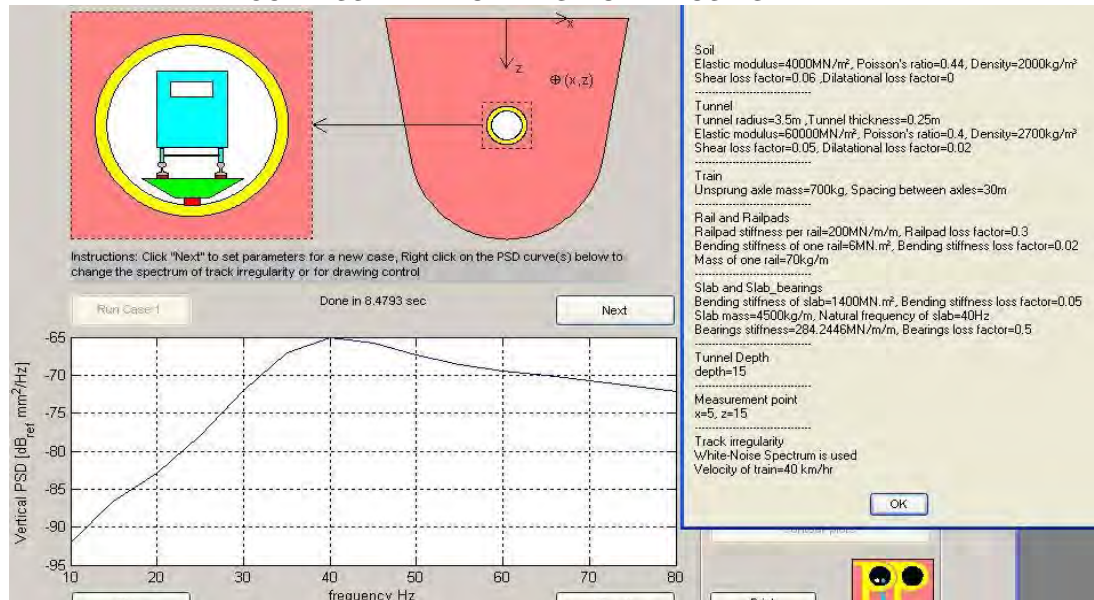
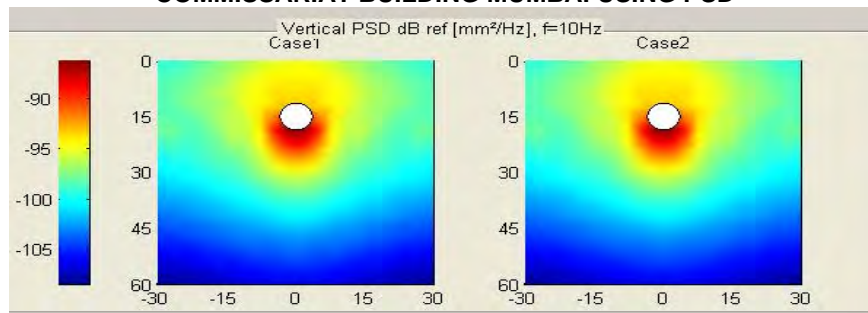


FIGURE 4.14
VIBRATION CONTOURS AT CENTRAL ASSURANCE BUILDING, OPP. TO
COMMISSARIAT BUILDING MUMBAI USING PSD



4.5.2.5 At Bhikha, Behram, Parsees Well, Hutatma Chowk

The result of the vibration prediction using PiP model is shown in **Figure 4.15**. The graph shows that the vertical Power Spectral Density (PSD) is rising at the beginning with the frequency; it is maximum at frequency 40 Hz. The peak vertical vibration due to metro rail passing at this location is 131 PSD (VdB). The vibration contour map is shown in **Figure 4.16**. The Figure 4.16 shows the clear pattern of vibration effect due to train passage. It can be seen that the vibration is high at the bottom portion of the track. The ground borne vibration at the surface would be 115 PSD (VdB), which do not have much effect on the surrounding buildings during operation.

The predicted vertical vibration due to metro rail passby at this location shows between 65 to 70 VdB. The predicted vibration is in safe and there would not be any impact on the nearby building structures during the operation of metro rail at this location

FIGURE 4.15
VIBRATION DUE TO TRAIN AT BHIKHA, BEHRAM, PARSEES WELL, HUTATMA CHOWK USING PiP

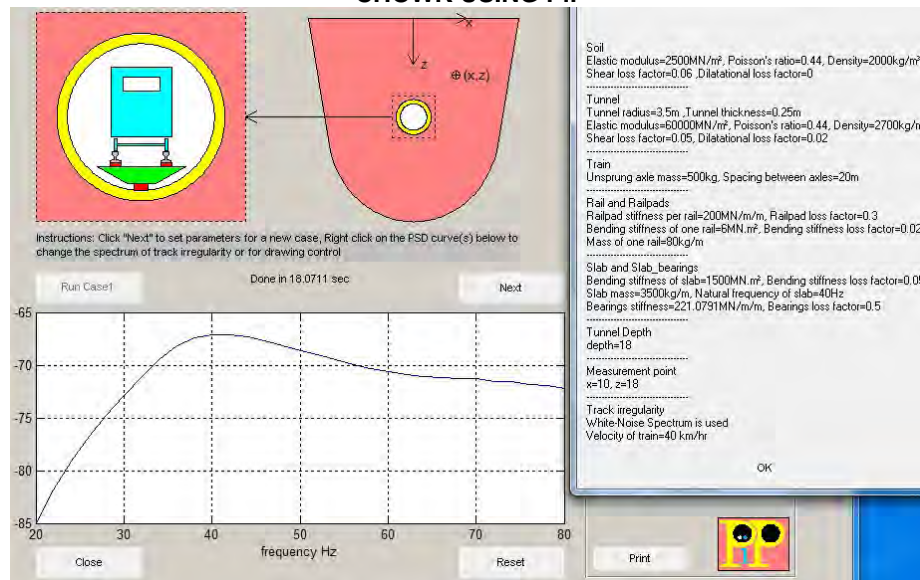
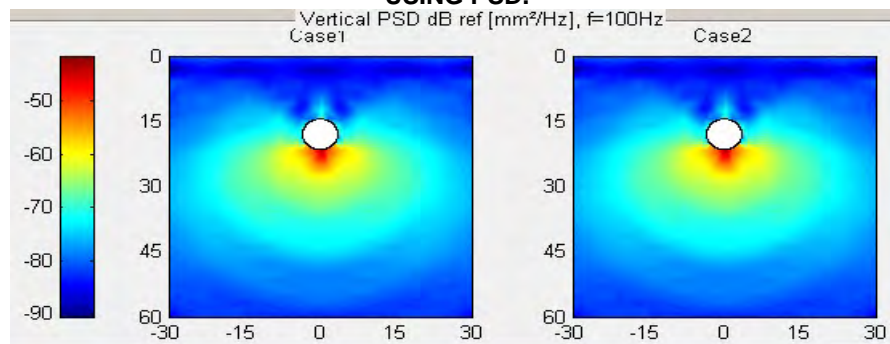


FIGURE 4.16
VIBRATION CONTOURS AT BHIKHA, BEHRAM, PARSEES WELL, HUTATMA CHOWK USING PSD.



4.5.2.6 At Chhatrapati Shivaji Terminus

The result of the vibration prediction using PiP model is shown in **Figure 4.17**. The graph shows that the vertical Power Spectral Density (PSD) is low from 10 to 20 Hz frequency after that is found rising. The peak vertical vibration due to metro rail passing at this location is 92 PSD (VdB). The vibration contour map is shown in **Figure 4.18**. The Figure 4.18 shows the clear pattern of vibration effect due to train passage. It can be seen that the vibration is high at the bottom portion of the track. The ground borne vibration at the surface would be 92 PSD (VdB), which do not have much effect on the surrounding buildings during operation.

The predicted vertical vibration due to metro rail passby at this location shows between 130 to 135 VdB. The predicted vibration is in safe and there would not be any impact on the nearby building structures during the operation of metro rail at this location.

FIGURE 4.17

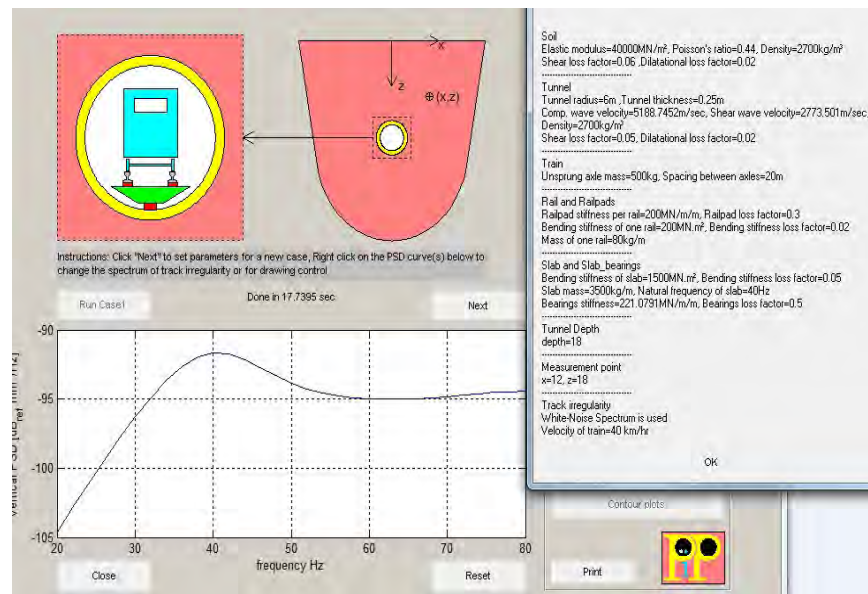
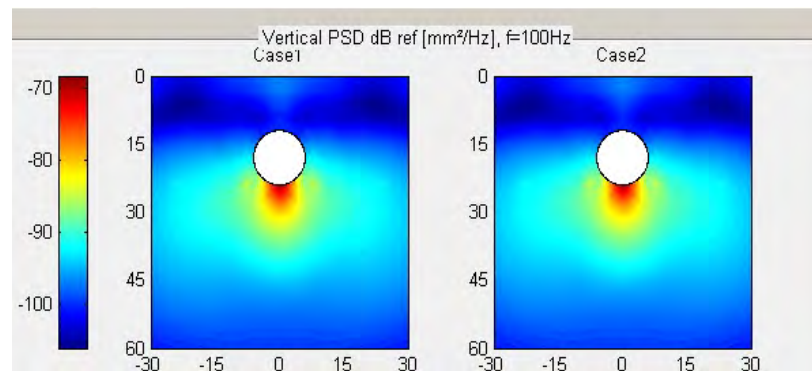


FIGURE 4.18
VIBRATION CONTOURS AT CHHATRAPATI SHIVAJI TERMINUS USING PSD.



The result of the vibration impact on the surrounding due to TBM and underground train traffic has been tabulated in **Table 4.7**. The limits for vibration is 65 VdB as per Federal Transit Administration (FTA) whereas 83 VdB is the maximum limit as per ISO -2361-2. The predicted vibration level during construction and operations seems to be higher than the standard limits. This is due to consideration of worst case scenario of having the subsoil condition as rocky structure and may be expected actually less than the predicted value.

TABLE 4.7
OVERALL RESULT OF VIBRATION IMPACT

| Sr. No | Location | Field Measured Average Ambient vertical vibration (VdB) | Vibration due to TBM Operation (VdB) | Vibration due to Metro Train Operation (VdB) | Limits/ Standards of Vibration in (VdB) |
|--------|--|---|--------------------------------------|--|---|
| 1 | Lady Willingdon Building, Dhobi Talao, near Metro Cinema. | 113.9 | 144 | 85 to 90 | 65- 83 |
| 2 | Narutamdas Bhau Jewelers, K.Gajanan Vertak Chowk, Lamington Road | 123.5 | 147.8 | 70 to 75 | 65- 83 |
| 3 | Mittal Towers, Maharshi Valmiki Chowk | 126 | 143 | 65 to 70 | 65- 83 |
| 4 | Central Assurance Building, opp to Commissariat Building, Dr. Dadabhai Naoroji Road. | 124 | 147.8 | 65 to 70 | 65- 83 |
| 5 | Bhikha, Behram, Parsees Well, Hutatma Chowk | 113.9 | 143 | 68 to 70 | 65- 83 |
| 6 | Chhatrapati Shivaji Terminus | 110-126 | 147.3 | 90-95 | 65- 83 |

4.5.3 Water Supply and Sanitation

Public Health facilities such as water supply and sanitation are very much needed at the stations. The water demands will be for drinking, toilet, cleaning and also for other purpose like AC, chiller etc. The Water Demand of existing Delhi Metro corridors considered for requirement of Mumbai metro. The demand is presented in **Table 4.8**. It is assumed that there would be similar water requirements in Mumbai Metro corridors also. Water should be treated before use upto WHO drinking water standards. Municipal supply/Ground water shall be used for this purpose. In addition, water will be required for contractor's camps during construction.

TABLE 4.8
WATER REQUIREMENT AT STATION

| S.No. | Particular | Water Demand at Each Station (KLD) | Total Water Demand (KLD) |
|--------------|--|------------------------------------|--------------------------|
| 1 | At Stations for Drinking Purpose | 6 | 162 |
| 2 | For AC, cleaning, chiller and other purposes | 240-250 | 6750 |
| Total | | | 6912 |

4.5.4 Electromagnetic Interference

Transmission lines do not usually interfere with normal television and radio reception. In some cases, interference is possible at a location close to the ROW due to weak broadcast signals or poor receiving equipment. An impact due to electromagnetic interference is insignificant as the proposed alignment is passing underground.

This interference may arise either from the electric field or from the magnetic field. 25 KV traction currents produce alternating magnetic fields that cause induced voltages to any conductor running along the track.

International consultative committee on telecommunications and Telegraphy (CCITT) gives the following formula to arrive at the minimum separation between contact wire and the communication line to limit the induced voltage to 300 Volts. The minimum spacing is given by $a = \frac{1}{3} \sqrt{E}$. Where, E is the contact wire voltage. For 25 kV systems this works out to 53 m.

4.6 IMPACTS DUE TO DEPOT

The depot at Araey colony is planned for metro corridors. The area of depot is about 26.407 hectares. The area at depot is vegetated with no habitation. The depot will have following facilities:

- Washing Lines,
- Operation and Maintenance Lines,
- Workshop, and
- Offices.

These facilities could generate water and noise issues. The depot areas are undulating & low laying and hence have to be filled up. The area will be levelled through cut and fill method within the depot and additional earth will be taken from tunnelling to raise the ground level. Problems anticipated at depot sites are:

- Water supply,
- Effluent Treatment,
- Oil Pollution
- Noise Pollution,
- Surface drainage,
- Solid Waste,
- Cutting of trees.

4.6.1 Water Supply

Water supply will be required for different purposes in the depot. The water requirement for train washing purpose will be 500 litres per day. About 160 KLD of fresh water will be required at Depot for different uses. Projected water demands are

summarised in **Table 4.9**. Other water requirement for horticulture, flushing urinals/closet will be met from recycled water.

TABLE 4.9
WATER DEMAND AT AAREY MILK COLONY DEPOTS

| S.NO | DEPOT | PROJECTED NUMBER OF CARS | PROJECTED WATER REQUIREMENT PER DAY (LITRES) |
|--------------|--|--------------------------------|--|
| 1 | Car Washing | 280 | 140000 |
| 2 | Floor Washing @ 0.5 lit/sqm | -- | 17,500 |
| 2 | Drinking Purpose: 300 persons @ 5 lit per person per day | -- | 1500 |
| Total | | | 1,60,000 |

The water after conventional treatment can be processed through Reverse Osmosis (RO) technology for specific use such as washing of equipment/ trains. This will reduce the fresh water requirement.

4.6.2 Effluent Treatment

About 130 KLD of waste is to be generated at depot, which will be treated at 160 KLD effluent treatment plant. The treated waste water will be tested for Inland Water Discharge Standard before release in to Mithi River. The part of the water will be recycled to use at depot horticulture purpose.

4.6.3 Oil Pollution

Oil spillage during change of lubricants, cleaning and repair processes, in the maintenance Depot cum workshop for maintenance of rolling stock, is very common. The spilled oil should be trapped in oil and grease trap. The collected oil would be disposed off to authorised collectors, so as to avoid any underground/ surface water contamination.

4.6.4 Noise Pollution

The main source of noise from depot is during operation of workshop. The roughness of the contact surfaces of rail, wheel and train speed is the factors, which influence the magnitude of rail - wheel noise. The vibration of concrete structures also radiates noise. No impact on the ambient noise is anticipated due to mild activities.

4.6.5 Surface Drainage

Due to the filling of the low-lying area for the construction of depots, the surface drainage pattern will change. Suitable drainage measures will be adopted to drain off the area suitably in the nearby Mithi River.

4.6.6 Solid Waste

At per available data, it is estimated that about 1.8 Ton per month of solid waste will be generated from the Depot.

4.6.7 Cutting of Trees

About 1652 numbers of trees are observed at Depot at Aarey milk area. The details of tree cut are mentioned in the section 3.7.1. The details of tree likely to be cut and transplanted are given in the Environmental Management Plan.

4.7 EPILOGUE

Based on above negative impacts, a checklist of impacts has been prepared along with positive impacts in **Chapter-5**. The net resultant impacts without management plans are also summarised. The management plans to mitigate the negative impacts are reported in **Chapter-6**.

CHAPTER-5

POSITIVE ENVIRONMENTAL IMPACTS

5.1 POSITIVE ENVIRONMENTAL IMPACTS

Based on project particulars (**Chapter-2**) and existing environmental conditions (**Chapter -3**), potential impacts that are likely to result from the proposed Metro Rail development have been identified and wherever possible these have been quantified. This chapter deals with the positive impacts of the project. The introduction of Metro Rail will also yield benefits from non-tangible parameters such as saving due to equivalent reduction in road construction and maintenance, vehicle operating costs, less atmospheric air pollution and socio-economic benefits of travel time, better accessibility, better comfort and quality of life. However, all benefits cannot be evaluated in financial terms due to non-availability of universally accepted norms. The parameters such as economic growth, improvement in quality of life, reduction in public health problems due to reduction in pollution, etc have not been quantified.

Various positive impacts have been listed under the following headings:

- Employment Opportunities,
- Benefit to Economy,
- Mobility,
- Safety,
- Traffic Congestion Reduction,
- Reduction in the number of Vehicle Trips on the road,
- Less Fuel Consumption,
- Reduced Air Pollution,
- Carbon Dioxide Reduction,
- Reduction in Number of Buses,
- Saving in Road Infrastructure, and
- Traffic Noise Reduction.

5.1.1 Employment Opportunities

The project is likely to be completed in a period of about 5 years. During this period manpower will be needed to take part in various activities. About 2,500 persons are likely to work during peak period of activity during construction. In operation phase of the project about 45 persons per kilometre length of the corridor, ie (approx. 1,510 persons) will be employed for operation and maintenance of the proposed system. Thus the project would provide substantial direct employment; besides, more people would be indirectly employed in allied activities and trades.

5.1.2 Benefit to Economy

In the present context, the project will streamline and facilitate easy movement of public in Mumbai city. The metro rail will yield tangible and non-tangible saving due to equivalent reduction in road traffic and certain socio-economic benefits. Introduction of this metro rail project, Line III of Phase I in Mumbai city will result in the reduction in number of buses and private vehicles. This, in turn will result in significant social and economic benefits due to reduction in fuel consumption, vehicle operating cost and travel time of passengers. This will facilitate the movement of people fast. With the development of this corridor, it is likely that more people will be involved in trade, commerce and allied services.

5.1.3 Mobility

The proposed Mumbai Metro Colaba – Bandra - Seepz networks are estimated to carry 1.38 million passengers per day, in the year 2031. The maximum PHPDT on any section will be more than 24,800 by 2031. Passenger average time saved will be about 60 minutes by year 2031. The proposed development will reduce journey time to an extent as indicated in the **Table 5.1**.

TABLE 5.1
JOURNEY TIME

| S. No | Section | Length in km | Journey Time (Min) | Type of Corridor Proposed |
|-------|---------------------|-----------------|-----------------------|------------------------------|
| 1. | Colaba-Bandra-SEEPZ | 33.508 | 60 | Underground |

5.1.4 Safety

According to the National Crime Record Bureau's report, Mumbai tops in the list of accidents in India. It accounts for one out of every five fatal accidents in the country. This latest compiled data with the home ministry shows that Mumbai accounts for 18.5% of total accidents in the country. Kolkata, with a record of 1.8%, comes at the bottom of the list. Substantial decrease in road accident has been noticed after 2007 with the implementation of Delhi Metro Phase I & II in Delhi. Hence, operation of Mumbai Metro Rail will also provide improved safety and lower the number of accidental deaths.

5.1.5 Traffic Congestion Reduction

To meet the forecast transport demand in the year 2031, it is estimated that the number of buses will have to be more. During this period personalised vehicles may also be grown. Together, they will compound the existing problems of congestion and delay. The proposed development will reduce journey time and hence congestion and delay.

5.1.6 Reduction in the number of Vehicle Trips on the road

The number of vehicle trips in the years 2016, 2021, 2031 and 2041 with and without metro rail is projected in **Table 5.2**. After the introduction of metro rail system the reduction of vehicles for the years 2016, 2021, 2031 and 2041 is as indicated in **Table 5.3**. Similarly vehicle trip KMs and reduction in vehicle trip KMs are summarized in **Table 5.4** and **Table 5.5** respectively.

The basis of reduction of vehicle is shift of ridership from road vehicle to the proposed system. The reduction in number of vehicles gives benefits to economy by reduction in Vehicle Operating Cost (VOC), Fuel Consumption, Pollution Load, Accidents and Travel Time etc.

TABLE 5.2
NUMBER OF VEHICLES TRIPS WITH AND WITHOUT METRO CORRIDOR (Avg. Daily)

| MODE | No of Vehicle Trips without C-B-S Metro | | | | No of Vehicles Trips with C-B-S Metro | | | |
|------------|---|----------|----------|----------|---------------------------------------|----------|----------|----------|
| | 2016 | 2021 | 2031 | 2041 | 2016 | 2021 | 2031 | 2041 |
| Car + Taxi | 4628346 | 5365521 | 6540541 | 7972882 | 4552876 | 5273172 | 6428421 | 7838339 |
| 2W | 7239698 | 8392794 | 10230769 | 12471251 | 7060698 | 8173760 | 9964844 | 12152141 |
| Bus | 160988 | 186629 | 227500 | 277321 | 151680 | 175239 | 213672 | 260728 |
| Auto | 1510263 | 1750809 | 2352941 | 2868222 | 1400758 | 1616812 | 2190258 | 2673002 |
| Total | 13539295 | 15695754 | 19351751 | 23589676 | 13166012 | 15238983 | 18797195 | 22924209 |

TABLE 5.3
REDUCTION IN VEHICLE TRIPS (Avg. Daily)

| S.NO. | MODE | Reduction of Vehicle Trips with C-B-S Metro | | | |
|-------|--------------|---|---------------|---------------|---------------|
| | | 2016 | 2021 | 2031 | 2041 |
| 1. | Car + Taxi | 75470 | 92350 | 112120 | 134544 |
| 2. | 2W | 179000 | 219034 | 265925 | 319110 |
| 3. | Bus | 9308 | 11390 | 13828 | 16594 |
| 4. | Auto | 109506 | 133998 | 162684 | 195220 |
| | Total | 373283 | 456771 | 554556 | 665468 |

TABLE 5.4
NUMBER OF VEHICLES TRIP KMs WITH AND WITHOUT METRO CORRIDOR (Avg. Daily)

| MODE | No of Vehicle Trip KMs without C-B-S Metro | | | | No of Vehicles Trip KMs with C-B-S Metro | | | |
|------------|--|-----------|-----------|-----------|--|-----------|-----------|-----------|
| | 2016 | 2021 | 2031 | 2041 | 2016 | 2021 | 2031 | 2041 |
| Car + Taxi | 55540150 | 64386256 | 78486486 | 95674589 | 54634509 | 63278060 | 77141050 | 94060065 |
| 2W | 108595469 | 125891912 | 153461538 | 187068759 | 105910475 | 122606396 | 149472663 | 182282109 |
| Bus | 1609880 | 1866292 | 2275000 | 2773212 | 1516800 | 1752394 | 2136719 | 2607275 |
| Auto | 12082107 | 14006474 | 18823529 | 22945777 | 11206062 | 12934493 | 17522061 | 21384015 |
| Total | 177827607 | 206150934 | 253046554 | 308462338 | 173267846 | 200571344 | 246272493 | 300333465 |

TABLE 5.5
REDUCTION IN VEHICLE TRIP KMs WITH METRO CORRIDOR (Avg. Daily)

| S.NO. | MODE | Reduction of Vehicle Trip KMs with C-B-S Metro | | | |
|-------|--------------|--|----------------|----------------|----------------|
| | | 2016 | 2021 | 2031 | 2041 |
| 1. | Car + Taxi | 905641 | 1108196 | 1345437 | 1614524 |
| 2. | 2W | 2684994 | 3285516 | 3988875 | 4786650 |
| 3. | Bus | 93080 | 113898 | 138281 | 165937 |
| 4. | Auto | 876045 | 1071980 | 1301468 | 1561762 |
| | Total | 4559761 | 5579590 | 6774061 | 8128873 |

5.1.7 Less fuel Consumption Due to reduction in Vehicle

There will be a reduction in number of vehicle trips on implementation of this project. Therefore, it is estimated that both petrol and diesel consumption will also get reduced. There is an inter-fuel substitution of petrol and diesel to electricity that could result in savings of foreign exchange and a reduction of air pollution. Fuel saved due to traffic diverted to the metro rail is estimated by the diverted traffic described above and the annual run and fuel consumption norms of different vehicles. **Table 5.6** provides information about the savings in fuel consumption due to reduction of vehicles in Mumbai for the years 2016, 2021, 2031 and 2041. These fuel savings are valued at 2011 prices (Rs.67.00/L for petrol and Rs.41.00/L for diesel) the corresponding fuel savings for buses, car + taxi and 2/3 wheelers are as shown in **Table 5.7**.

TABLE 5.6
SAVINGS IN FUEL CONSUMPTION DUE TO REDUCTION OF VEHICLES (Avg. Daily)

| MODE | Reduction in Vehicle Trips KMs with CBS Metro | | | | Fuel Consumption Norm (Km/L) | Reduction in Fuel Consumption (litres) | | | |
|---------------------|---|---------|---------|---------|------------------------------|--|--------|--------|--------|
| | 2016 | 2021 | 2031 | 2041 | | 2016 | 2021 | 2031 | 2041 |
| Bus (Diesel) | 93080 | 113898 | 138281 | 165937 | 6 | 15513 | 18983 | 23047 | 27656 |
| Car +Taxi(Petrol) | 905641 | 1108196 | 1345437 | 1614524 | 14 | 64689 | 79157 | 96103 | 115323 |
| 2-3Wheeler (Petrol) | 3561039 | 4357496 | 5290343 | 6348412 | 30 | 118701 | 145250 | 176345 | 211614 |

TABLE 5.7
MONEY SAVING DUE TO REDUCTION OF VEHICLES (Avg. Daily)

| MODE | MONETARY VALUE(RS LAKH) | | | |
|---------------------|-------------------------|-------|--------|--------|
| | 2016 | 2021 | 2031 | 2041 |
| Bus (Diesel) | 6.36 | 7.78 | 9.45 | 11.34 |
| Car (Petrol) | 43.34 | 53.04 | 64.39 | 77.27 |
| 2-3Wheeler (Petrol) | 79.53 | 97.32 | 118.15 | 141.78 |

5.1.8 Reduced Air Pollution

Reduction in traffic on Mumbai roads due to proposed metro rail could lead to reduce air pollution. Reduction in number of vehicles and the Emission factor of vehicles as per Euro-II norms given in **Table 5.8** and the reduction level of different pollutants like PM, NO_x, HC, CO and CO₂ for the years 2016, 2021 and 2031 and 2041 is given in **Table 5.9**.

TABLE 5.8
EMISSION FACTOR OF VEHICLES AS PER EURO-II NORMS (G/KM)

| MODE | PM | NOX | HC | CO |
|------------|-------|------|------|------|
| Bus | 0.05 | 0.87 | 2.75 | 0.66 |
| Car | 0.03 | 0.2 | 0.25 | 1.98 |
| 2- Wheeler | 0.075 | 0.3 | 0.7 | 2.2 |

TABLE 5.9
REDUCTION IN POLLUTION EMISSION DUE TO REDUCTION OF VEHICLES
(TONNES/YEAR)

| MODE | Year | | | |
|--|----------------|----------------|----------------|----------------|
| | 2016 | 2021 | 2031 | 2041 |
| Emission reduction of Particulate Matter (PM) | | | | |
| Bus | 1.70 | 2.08 | 2.52 | 3.03 |
| Car | 9.92 | 12.13 | 14.73 | 17.68 |
| 2/3 Wheelers | 97.48 | 119.29 | 144.82 | 173.79 |
| Total | 109.10 | 133.50 | 162.08 | 194.50 |
| Emission reduction of Oxides of Nitrogen NOx | | | | |
| Bus | 29.56 | 36.17 | 43.91 | 52.69 |
| Car | 66.11 | 80.90 | 98.22 | 117.86 |
| 2/3 Wheelers | 389.93 | 477.15 | 579.29 | 695.15 |
| Total | 485.60 | 594.21 | 721.42 | 865.70 |
| Emission of reduction of Hydrocarbons HC | | | | |
| Bus | 93.43 | 114.33 | 138.80 | 166.56 |
| Car | 82.64 | 101.12 | 122.77 | 147.33 |
| 2/3 Wheelers | 909.85 | 1113.34 | 1351.68 | 1622.02 |
| Total | 1085.91 | 1328.79 | 1613.25 | 1935.90 |
| Emission reduction of Carbon Monoxide CO | | | | |
| Bus | 22.42 | 27.44 | 33.31 | 39.97 |
| Car | 654.51 | 800.89 | 972.35 | 1166.82 |
| 2/3 Wheelers | 2859.51 | 3499.07 | 4248.15 | 5097.77 |
| Total | 3536.44 | 4327.40 | 5253.80 | 6304.57 |
| Emission reduction of Carbon Dioxide CO₂ | | | | |
| Bus | 35.24 | 43.12 | 52.35 | 62.82 |
| Car | 1028.51 | 1258.55 | 1527.97 | 1833.57 |
| 2/3 Wheelers | 4493.52 | 5498.54 | 6675.66 | 8010.79 |
| Total | 5557.27 | 6800.20 | 8255.98 | 9907.17 |

5.1.9 Carbon Dioxide Reduction

Carbon dioxide is one of the major greenhouse gases, which directly deplete the ozone layer. To reduce the overall greenhouse gas emissions International Emission Trading (IET) Mechanism has been followed under Kyoto Protocol. Under IET mechanism, countries can trade in the international carbon credit market. Countries with surplus credits can sell the same to countries with quantified emission limitation and reduction commitments under the Kyoto Protocol. Carbon credits are measured in units of certified emission reductions (CERs). Each CER is equivalent to one ton of carbon dioxide reduction. Therefore, 5557.27, 6800.20, 8255.98 and 9907.17 Carbon credits per year will be achieved through this project in the 2016, 2021, 2031 and 2041 respectively. In economic terms it will be valued as Rs. 23.01 lakh (5557.27 (Carbon Credit) X 6 (Amount in Euro) X 69 (Amount in Rs.)), Rs. 28.15 lakh (6800.20 (Carbon Credit) X 6 (Amount in Euro)

X 69 (Amount in Rs.), Rs. 34.18 lakh (8255.98 (Caron Credit) X 6 (Amount in Euro) X 69 (Amount in Rs.) and Rs. 41.02 lakh (9907.17 (Caron Credit) X 6 (Amount in Euro) X 69 (Amount in Rs.) for year 2016, 2021, 2031 and 2041 respectively.

5.1.10 Reduction in Number of Buses

The requirement of buses is estimated to be 450 numbers to cater the additional ridership due to increase in traffic on road in absence of Mumbai metro. This will save an amount equal to Rs. 2203 million towards capital cost of bus system.

5.1.11 Saving in Road Infrastructure

The total road network in the Mumbai city is 1889 km and additional 182 km road infrastructure will be required to cater the additional load. About 10% of road infrastructure will be saved.

5.1.12 Traffic Noise Reduction

Reduction in traffic volume affects the noise levels. A 50% reduction of the traffic volume may results in a 3 dB reduction in noise levels, regardless of the absolute number of vehicles. Reduction in traffic volume of 10% & 50% reduces noise at the tune of 0.5 dB & 3.0 dB respectively. An introduction of Mumbai Metro Rail Line III substantially reduces the vehicular traffic which ultimately reduces noise level.

5.2 CHECKLIST OF IMPACTS

The impact evaluation determines whether a project development alternative is in compliance with existing standards and regulations. It uses acceptable procedures and attempts to develop a numeric value for total environmental impact. A transformation of the review of multiple environmental objectives into a single value or a ranking of projects is the final step in impact assessment. There are about hundred methods for carrying out impact assessment, which can be grouped into the following categories:

- Ad – hoc method,
- Checklist,
- Matrix,
- Network,
- Overlays,
- Environmental Index and
- Cost Benefit analysis.

Each of the methods is subjective in nature and none of these is applicable in every case. Of the 7 methods listed above, checklist has been used and presented.

Checklist is a list of environmental parameters or impact indicators which encourages the environmentalist to consider and identify the potential impacts. A typical checklist identifying anticipated environmental impacts is shown in **Table 5.10**.

TABLE 5.10
CHECKLIST OF IMPACTS

| S. No. | Parameter | Negative Impact | No Impact | Positive Impact |
|-----------|---|-----------------|-----------|-----------------|
| A. | Impacts due to Project Location | | | |
| i. | Displacement of People | * | | |
| ii. | Change of Land use | * | | |
| iii. | Loss of Trees | * | | |
| iv. | Loss of Cultural and Historical Structures | | * | |
| v. | Drainage & Utilities Problems | * | | |
| vi. | Impact on Local Transport Utilities | | | * |
| B. | Impact due to Project Design | | | |
| i. | Platforms - Inlets and Outlets | | * | |
| ii. | Ventilation and Lighting | | * | |
| iii. | Railway Station Refuse | * | | |
| iv. | Risk due to Earthquakes | | * | |
| C. | Impact due to Project Construction | | | |
| i. | Soil Erosion | * | | |
| ii. | Traffic Diversions and Risk to Existing Buildings | * | | |
| iii. | Air Pollution | * | | |
| iv. | Noise Pollution | * | | |
| v. | Impact due to Vibration | | * | |
| vi. | Health risk at construction site | * | | |
| vii. | Impact on Sensitive Receptors | | * | |
| viii. | Problem of excavated soil disposal | * | | |
| ix. | Dust Generation | * | | |
| x. | Problems of Soil Disposal | * | | |
| xi. | Labour Camp | * | | |
| D. | Impact due to Project Operation | | | |
| i. | Noise & Vibration | * | | |
| ii. | Water Demands | * | | |
| iii. | Refuse disposal and sanitation | * | | |
| iv. | Electromagnetic Interference | | * | |
| v. | Employment Opportunities | | | * |
| vi. | Benefit to Economy | | | * |

| S. No. | Parameter | Negative Impact | No Impact | Positive Impact |
|--------|------------------------------|-----------------|-----------|-----------------|
| vii. | Mobility | | | * |
| viii. | Safety | | | * |
| ix. | Traffic Congestion Reduction | | | * |
| x. | Less fuel Consumption | | | * |
| xi. | Reduced Air Pollution | | | * |
| xii. | Carbon dioxide Reduction | | | * |
| xiii. | Traffic Noise Reduction | | | * |
| xiv. | Reduction in Buses | | | * |
| xv. | Reduction in Infrastructure | | | * |

CHAPTER – 6

ENVIRONMENTAL MANAGEMENT PLAN

6.1 APPROVALS/CLEARANCES REQUIREMENT

On the basis of baseline study and identified negative impacts, issues like tree cutting, development near World Heritage Structures and muck disposal etc needs necessary approvals/clearance from the relevant concerned authorities. PMU will ensure that all necessary approvals/clearances are in place before implementation. Before commencement of the construction the necessary permission required for the project is given in **Table 6.1**.

TABLE 6.1
NECESSARY APPROVALS/CLEARANCES REQUIREMENT

| Issues | Provision of Laws & Regulations | Due Date | Required Documentation | Approval Authority |
|--|---|---------------------------------|--|---|
| Permission for Tree Cutting | Maharashtra felling of Trees (Regulation Act, 1964) Amended in 2006. | 67 days before the construction | Application enclosing Detailed Address of Site, Plans & drawings of the proposed construction approved by competent authority, Plan showing indication of trees required to be felled. | The Tree Authority MCGM, Mumbai |
| Development permission near World Heritage Structures. | - | Before Construction | Format of submission for MHCC NOC. Detailed Address of Site, Location of Heritage structure w.r.t Metro Alignment. Plans & drawings of the proposed construction activities. | Mumbai Heritage committee, MCGM |
| Muck disposal permission | Environment Protection Act | Before Construction | Location of Muck Dumping Site | State Pollution Control Board/ MoEF (Govt. Of India) |
| Resettlement Permission | Resettlement & Rehabilitation Policy for Mumbai Urban Transport Project (MUTP), 1997 Amended in Dec 2007. | Before Construction | Social Impact Assessment & RAP Report | State Government, Maharashtra. |
| Consent for Establishment | Environment Protection Act | Before Construction | Site plan, sources of effluent discharge/emissions, Details of Water Pollution Control/Air Pollution Control, Ambient Air Quality Report, Consent fees, | State Pollution Control Board (Maharashtra Pollution Control Board) |
| Consent to Operate | Environment Protection Act | After Construction | Site plan, Latest analysis report of effluent | State Pollution Control Board |

| | | | | |
|--|--|--|--|---------------------------------------|
| | | | discharge/emissions, Details of Water Pollution Control/Air Pollution Control, Ambient Air Quality Report, Consent fees. | (Maharashtra Pollution Control Board) |
|--|--|--|--|---------------------------------------|

6.2 MANAGEMENT PLANS

The Mumbai Metro Rail Project will provide employment opportunity, quick mobility service and safety, traffic de-congestion, less fuel consumption and reduced air pollution on one hand and problems of muck disposal, traffic diversion, utility dislocation etc. on the other hand during construction and operation of the project.

Protection, preservation and conservation of environment have always been a primary consideration in Indian ethos, culture and traditions. Management of Environment by provision of necessary safeguards in planning of the project itself can lead to reduction of adverse impacts due to a project. This chapter, therefore, spells out the set of measures to be taken during project construction and operation to mitigate or bring down the adverse environmental impacts to acceptable levels based on the proposed Environmental Management Plan (EMP).

The most reliable way to ensure that the plan will be integrated into the overall project planning and implementation is to establish the plan as a component of the project. This will ensure that it receives funding and supervision along with the other investment components. For optimal integration of EMP into the project, there should be investment links for:

- Funding,
- Management and training, and
- Monitoring.

The purpose of the first link is to ensure that proposed actions are adequately financed. The second link helps in embedding training, technical assistance, staffing and other institutional strengthening items in the mitigation measures to implement the overall management plan. The third link provides a critical path for implementation and enables sponsors and the funding agency to evaluate the success of mitigation measures as part of project supervision, and as a means to improve future projects. This chapter has been divided into three sections:

- Mitigation measures,
- Disaster management, and
- Emergency measures.

For every issue discussed for above measures, the implementing agency as well as staffing, equipment, phasing and budgeting have been presented as far as possible. All required funds will be channeled through the project authority. The Environmental Management Plans have been prepared and discussed in subsequent sections.

6.3 MITIGATION MEASURES

The main aim of mitigation measures is to protect and enhance the existing environment of the project. This section includes measures for:

- Compensatory Afforestation,
- Construction Material Management,
- Safety Management Measures during the construction period
- Labour Camp,
- Energy Management,
- Hazardous Waste Management,
- Environmental Sanitation,
- Utility Plan,
- Archaeological and Historical Preservation,
- Air Pollution Control Measures,
- Noise Control Measures,
- Vibration Control Measures,
- Traffic Diversion/Management,
- Soil Erosion Control,
- Muck Disposal,
- Draining of Water from Tunnel,
- Water Supply, Sanitation and Solid Waste management,
- Sensitive Receptors
- Electromagnetic Interference
- Management Plans for Depot, and
- Training and Extension,
- Environmental Enhancement Measures

6.3.1 Compensatory Afforestation

A) Afforestation

The objective of the afforestation programme should be to develop natural areas in which ecological functions could be maintained on a sustainable basis. The Tree Authority of Mumbai is responsible for the tree cutting in the project area under Maharashtra (Urban

Areas) Protection and Preservation of Trees Act 1975, as modified up to 9th June 2004. According to the Tree Authority an application with site map should be submitted to authority for inspection and permission for cutting of tree. The Permission letter for removal of trees coming within the proposed construction area is enclosed as **Appendix 6.1**. As mentioned in section 3.7.1 about 2241 trees are likely to be affected due to the project. The detail of tree likely to be removed or transplanted is given in the **Table 6.2**.

TABLE 6.2
DETAILS OF TREES CUT AND TRANSPLANTATION

| Sr. No | Particulars | Affected Trees | Cut | Transplantation | Remarks |
|--------|-----------------|----------------|------------|-----------------|---|
| 1 | Along Alignment | 589 | 177 (30%) | 412 (70%) | (Stations, Entry & Exit) |
| 2 | Depot | 1652 | 496 (30%) | 660 (40%) | 30% (i.e 496) trees in depot area will remain as where it is. |
| | Total | 2241 | 673 | 1072 | |

The number of trees to be transplanted depends on the site condition and root investigation & health of tree. More stress will be given for transplantation of the tree rather than removal. The trees which are not possible to transplant will only be cut. The trees which are cut will be compensated by planting two times the number of trees. Hence, 673 trees are likely to be cut for which 1346 trees are required to be planted. The compensation for loss of these trees works out to Rs. 100.95 lakh @ Rs. 15000 per tree. The total area required for afforestation of these trees comes out to about 1.5 ha. It is presumed that Government land will be provided for afforestation; hence no land cost will be involved. Land for plantation of trees will be identified by the project proponent in consultation with Forest Department of State Government. Compensatory afforestation cost (excluding fencing) for 1.5 ha will be about Rs. 3.00 lakhs @ about Rs.200000 per ha. Fencing shall be provided in order to save the saplings from the animals. The cost towards fencing is estimated to be about Rs.2.00 lakh. Thus, the total cost of compensatory afforestation and fencing works out to **Rs. 105.95 lakhs**. The recommended plant species for afforestation includes gulmohar, neem, Pilkhan, Ashoka, Jamun, Desi Badam etc. The botanical names of the species to be planted are indicated in the **Table 6.3**.

TABLE 6.3
SCIENTIFIC NAMES OF TREE FOR PLANTATION

| S. No | Local Name | Botanical Name |
|-------|--------------|---------------------------|
| 1 | Gulmohar | <i>Delonix regia</i> |
| 2 | Neem | <i>Azadirachta indica</i> |
| 3 | Ashoka | <i>Saraca asoca</i> |
| 4 | Jamun | <i>Syzygium cumini</i> |
| 5 | Desi Badam | <i>Terminalia catappa</i> |
| 6 | Coconut Tree | <i>Cocos nucifera</i> |
| 7 | Jackfruit | <i>Artocarpus integra</i> |
| 8 | Karanj | <i>Pongamia pinnata</i> |
| 9 | Rubber Tree | <i>Ficus elastica</i> |
| 10 | Sheesham | <i>Dalbergia sissoo</i> |

B) Transplantation

The trees at station location along the proposed metro alignment will be transplanted in the nearby open area while transplantation of trees from the depot area will be done in the nearby available area within the Aarey milk colony itself in consultation with MCGM. The planning of depot will be done in such a way that 30% of the trees will be saved. The management plans for transplantation of trees are summarized below:

- Preliminary root investigation should be carried out,
- Health diagnosis of the tree should be carried out for treating infected trees,
- Soil condition where the tree has to be transplanted is thoroughly checked & necessary treatments are applied to the soil after digging a pit,
- The pit size has to be kept in accordance with the root ball of the tree,
- Packing material should be strong enough to hold the soil around the root zone,
- Crane should be used to lift the packed tree and a trolley or truck should be used to transport the tree,
- Timely feeding of the plant should be done with soluble fertilizers and watering,
- JCB should be used for digging pits,
- There should be regular monitoring for fertilizer schedules and the chemicals like insecticides and pesticides.
- Scaffolding should be used wherever required to support the trees,
- Any broken stems during transplantation should be removed cautiously.

After transplantation, there are chances of external infections to the tree which needs maintenance for at least 2-3 months.

The cost towards transplantation of trees varies with its girth. An average girth of 0.75 metre has been taken for the cost estimation. The cost for transplanting 1072 number of trees is about **Rs. 536.00 Lakhs** @ Rs. 50,000/- per tree transplantation. The cost i.e Rs. 50,000/- for one tree transplantation is including lead of 1.5 km with all tools, testing, man & machinery, necessary preparation and maintenance.

6.3.2 Construction Material Management

The construction material to be used for construction of Mumbai Metro Rail Project are coarse aggregates, cement, coarse sand, reinforcement steel, structural steel, water supply, drainage and sanitary fittings etc. The material will be loaded and unloaded by engaging labour at both the locations by the contractor.

The duties of the contractor will include monitoring all aspects of construction activities, commencing with the storing, loading of construction materials and equipment in order to maintain the quality. During the construction period, the construction material storage site

is to be regularly inspected for the presence of uncontrolled construction waste. Close liaison with the MMRDA Officer and the head of the construction crew will be required to address any environmental issues and to set up procedures for mitigating impacts. The scheduling of material procurement and transport shall be linked with construction schedule of the project. The Contractor shall be responsible for management of such construction material during entire construction period of the project. Sufficient quantity of materials should be available before starting the each activity. The contractor should test all the materials in the Government labs or Government approved labs in order to ensure the quality of materials before construction. This is also the responsibility of the contractor, which would be clearly mentioned in the contractor's agreement.

6.3.3 Safety Management Measures

Prior to the construction, identification of safety hazard would be made by Project Authority to establish the safety programmes following rules, regulations and guidelines. These would help to avoid and reduce the accidents. The comprehensive safety programmes will include deployment of a full time safety engineer who will prepare safety plan/schedule for their implementation during construction and operation. The emergency measures include tunnel evacuation plan and procedures independent of the tunnel power supply. The tunnel personnel would wear protective headgear, footwear and other special garments that applicable code requires. The specific working areas in underground construction can have their own unique hazards that personnel requires to be made aware of by providing training and displaying the instruction wherever it requires. The weatherproof first aid box will be made available at appropriate locations. The tunnel will be provided with mechanically induced reversible flow primary ventilation for all work areas. Detailed instructions will be followed for handling and storage of explosives to be used in controlled blasting if any.

6.3.4 Labour Camp

The Contractor during the progress of work will provide, erect and maintain necessary (temporary) living accommodation and ancillary facilities for labour to standards and scales approved by the MMRDA. All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. Safe drinking water should be provided to the dwellers of the construction camps. Adequate washing and bathing places shall be provided, and kept in clean and drained condition. Construction camps are to be the responsibility of the concerned contractors and these shall not be allowed in the construction areas but sited away. Adequate health care is to be provided for the work force. Deployment of labour at the construction site will be made by following the fairer process as mentioned in civil contract agreement.

Shelter at Workplace: At every workplace, shelter shall be provided free of cost, separately for use of men and women labourers. 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 0.5m² per head.

Canteen Facilities: A cooked food canteen on a moderate scale shall be provided for the benefit of workers wherever it is considered necessary. The contractor shall conform generally to sanitary requirements of local medical, health and municipal authorities and at all times adopt such precautions as may be necessary to prevent soil pollution of the site.

First aid facilities: At every workplace, a readily available first-aid unit including an adequate supply of sterilized dressing materials and appliances will be provided. Suitable transport will be provided to facilitate taking injured and ill persons to the nearest hospital. Construction contractor will provide health check-up camps for construction workers at least once in a month.

Day Crèche Facilities: At every construction site, provision of a day crèche shall be worked out so as to enable women to leave behind their children. At construction sites where 20 or more women are ordinarily employed, there shall be provided at least a hut for use of children under the age of 6 years belonging to such women. Huts shall not be constructed to a standard lower than that of thatched roof, mud walls and floor with wooden planks spread over mud floor and covered with matting. Huts shall be provided with suitable and sufficient openings for light and ventilation. There shall be adequate provision of sweepers to keep the places clean. There shall be two maidservants (or aayas) to the satisfaction of local medical, health, municipal or cantonment authorities. Where the number of women workers is more than 25 but less than 50, the contractor shall provide with at least one hut and one maidservant to look after the children of women workers. Size of crèches shall vary according to the number of women workers employed.

Prevention of Infectious Diseases: Construction workers are more prone to Infectious diseases such as HIV/AIDS. It should be prevented by following actions as depicted below:

- One-one interactions – helps to build confidence,
- Counselling- addressing the myths and misconceptions,
- Community events-street theatre, puppetry, cultural programs are proven communication tools to the illiterate community to message dissemination,
- STD clinic - early identification through testing,
- Condom promotion- encouraging condom usage, an accessible place, made available at all times and free distribution.
- Advertisement board at appropriate location will be put to make aware about the infectious diseases.
- Co-ordination with State Aids Control Society and Health Department

Sanitation Facilities: Construction camps shall be provided sanitary latrines and urinals. Drains for waste water should be provided for the flow of used water outside the camp. Drains and ditches should be treated with bleaching powder on a regular basis. The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Compliance with the relevant legislation must be strictly adhered to. Garbage bins must be provided in the camp and regularly emptied and the garbage disposed off in a hygienic manner.

Water Supply and Waste water Treatment Facility for Workers Camps: It is estimated that about 31.5 KLD water will be required daily for the camps, which will be taken from borewell/Municipal Water Supply. Borewell water will be chlorinated for use as drinking water. About 80% of the water supply will be generated as sewage/waste water, which needs to be treated before disposal or may be connected to nearby sewerage network.

As per the Contract Labour (Regulation & Abolition) Act, 1970, there shall be at least one latrine for every 25 male. The sewage from the community water closet would be treated through septic tank and disposed off through soak pits. The drinking water facilities and sewage disposal sites should be located away from each other. A provision of **Rs. 9.55 Lakhs** would be made for these facilities as reported in **Table 6.4**.

TABLE 6.4
COST OF WATER SUPPLY AND SANITATION FACILITIES

| Sr. No | Description | Rate (Rs/Unit) | Numbers | Cost (Rs. Lakhs) |
|--------------|---|----------------|---------|------------------|
| 1 | Water Treatment & Supply Facilities | 1,50,000 | 3 | 4,50,000 |
| 2 | Community water closet | 25,000 | 10 | 2,50,000 |
| 3 | Septic Tank & Soak pit including connection | 85,000 | 3 | 2,55,000 |
| Total | | | | 9,55,000 |

Solid Waste Management

It is estimated that about 157.5 Kg per day municipal solid waste will be generated from the labour camp. The collection, conveyance and disposal facilities shall be provided by . providing 20 litres capacity bin with handle and cover for 8 workers. In addition, one community bins would be provided for effective collection of the waste. The disposal of the waste will be at municipal corporation landfill site. The cost of these facilities including maintenance for 5 years works out to be about **Rs. 12.01 Lakhs** as summarized in **Table 6.5**.

TABLE 6.5
COST OF DOMESTIC SOLID WASTE MANAGEMENT FACILITIES

| Sr. No | Description | Rate (Rs/Unit) | Numbers | Cost (Rs. Lakhs) |
|--------------|---|-----------------|---------|------------------|
| 1 | Solid waste collection bins @ Rs. 200/bin Community bin 3 no. @ Rs. 15,000/bin | 6,000 45,000 | 30 3 | 51,000 |
| 2 | Transportation | Lump sum | - | 2,50,000 |
| 3 | Manpower cost of 3 persons @ 5000 per person per year for 5 years | 3x60x6,000 | 3 | 9,00,000 |
| Total | | | | 12,01,000 |

6.3.5 Energy Management

Energy conservation measures are often the easiest, quickest and cheapest way to reduce costs and implement environmentally pro-active Energy conservation program both on energy demand and supply. The contractor shall use and maintain equipment so as to conserve energy and shall be able to produce demonstrable evidence of the same upon MMRDA request.

Measures to conserve energy include but not limited to the following:

- Use of energy efficient motors and pumps,
- Use of energy efficient lighting, which uses energy efficient luminaries,
- Adequate and uniform illumination level at construction sites suitable for the task,
- Proper size and length of cables/ wires to match the rating of equipment, and
- Use of energy efficient air conditioner.

The contractor shall design site offices for 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.

6.3.6 Hazardous Waste Management

Hazardous Waste needs to be stored at a secured place. 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 contractor shall identify the nature and quantity of hazardous waste generated as a result of his activities. Hazardous Waste will be handled and disposed as per the Hazardous waste (M& H) Rules, 2008 and shall be authorized with Maharashtra Pollution Control Board. Outside the storage area, the contractor shall place a 'display board', which will display quantity and nature of hazardous waste. The labeling and packaging is required to be easily visible and be able to withstand physical conditions and climatic factors. The contractor shall approach only

Authorized Recyclers with MPCB for disposal of Hazardous Waste, under intimation to the MMRDA.

6.3.7 Environmental Safeguard

Environmental sanitation also referred to as Housekeeping, is the act of keeping the working environment cleared of all unnecessary waste, thereby providing a first-line of defense against accidents and injuries. Contractor shall understand and accept that improper environmental sanitation is the primary hazard at any construction site and ensure that a high degree of environmental sanitation is always maintained. Environmental sanitation is the responsibility of all site personnel, and line management commitment shall be demonstrated by the continued efforts of supervising staff towards this activity.

General environmental sanitation shall be carried out by the contractor to ensure for good environmental sanitation at Work Site, Construction Depot, Batching Plant, Labour Camp, Stores, Offices and toilets/urinals. Towards this the Contractor shall constitute a special group of environmental sanitation personnel. This group shall ensure daily cleaning at work sites and surrounding areas and maintain a register as per the approved format by the MMRDA.

Team of environmental sanitation squad shall carry out:

- 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 and endanger to 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.
- The structural dimension of the barricade, material and composition, its colour scheme, MMRDA logo and other details.
- All stairways, passageways and gangways shall be maintained without any blockages or obstructions. All emergency exits passageways, exit 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.
- All surplus earth and debris are removed/disposed off from the working areas to officially designated dump sites. Trucks carrying sand, earth and any pulverized materials etc. in order to avoid dust or odour impact shall be covered while moving.

- No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.
- 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.
- Water logging or bentonite spillage on roads shall not be allowed.
- 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.
- Flammable chemicals / compressed gas cylinders shall be safely stored.
- Unused/surplus cables, steel items and steel scrap lying scattered at different places within the working areas shall be removed to identified locations(s).
- All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from work place to identified location(s).
- Empty cement bags and other packaging material shall be properly stacked and removed.

The Contractor shall ensure that all his sub-contractors maintain the site reasonably clean through provisions related to environmental sanitation (house keeping).

6.3.8 Utility

The proposed Metro alignment is passing through underground, hence utilities like sewers, water mains, storm water drains, telephone cables, electrical transmission lines, electric poles, traffic signals etc. would not get affected except at locations where construction of stations is proposed through cut and cover method. These utility services have to be maintained in working order during different stages of construction by temporary / permanent diversions or by supporting in position. As such, these may affect construction and project implementation time schedule/costs, for which necessary planning / action needs to be initiated in advance.

The Organizations / Departments responsible for concerned utility services are reported in **Table 6.6**.

While planning for diversion of underground utility services e.g. sewer lines, water pipe

lines, cables etc., during construction of Metro rail, the following guidelines could be adopted:

- Utility services shall be kept operational during the entire construction period and after completion of project. All proposals should therefore, ensure their uninterrupted functioning.

TABLE 6.6
ORGANIZATIONS RESPONSIBLE FOR UTILITIES AND SERVICES

| S. NO. | ORGANIZATION/ DEPARTMENT | UTILITY/SERVICES |
|--------|---|---|
| 1. | Brihan Mumbai Municipal Corporation | Sewerage and drainage lines. Water mains and their service lines, including hydrants and fountains etc, water treatment plants, pumping stations, Roads, surface water drains, nallahs, sewer lines, street lights, high mast lights etc. |
| 2. | Public Works Department | Roads, surface water drains, nallahs etc. |
| 3. | NHAI | Roads, surface water drains, nallahs etc. |
| 4. | Brihanmumbai Electric Supply and Transport (BEST) for island city, and Reliance Energy, Tata Power and Mahavitaran (Maharashtra State Electricity Distribut. area | Power cables and their appurtenances, pole mounted transformers. |
| 5. | Mahanagar Telephone Nigam Ltd. (MTNL) | Telecommunication cables, junction boxes, telephone posts, O.H. lines etc. |
| 6. | Office of Commissioner of Police, Mumbai | Traffic signal posts, junction boxes and cable connection etc. |
| 7. | Reliance Mobile India Limited, Idea, Airtel and Tata Tele service India Limited | Telecommunication cables, junction boxes etc. |
| 8. | Mahanagar Gas Limited | Gas Pipelines |

6.3.9 Archaeological and Historical Structure Preservation

No damage to Archeological Monuments is anticipated. However, during construction, archaeological or historical structures may get affected by direct or indirect construction activity. Chhatrapati Shivaji Terminus (formerly Victoria Terminus) is the World Heritage Cultural Property located at close vicinity to the alignment, for which necessary procedure will be followed to obtain the necessary construction permit from MCGM. No Objection Certificate (NOC) will be taken from the Mumbai Heritage Conservation Committee, MCGM. The tentative application format is enclosed at **Appendix 6.2**. Prior to the initiation of construction, MMRDA will conduct condition survey of all historical important structures in the vicinity of alignment. This survey will help to identify the impact on the structures during construction and operation of the project. Any impact would be compensated by adequate management plan to preserve the structures. The management plan will include ground vibration monitoring during construction and operation of project.

The tunnel will be constructed by using the state of the art technology i.e. Tunnel Boring Machine which gives negligible vibration and does not affect the surrounding structure. The stations are being constructed by cut and cover method which is widely accepted and the safest technique being adopted by metros in India and abroad. The above technology has been adopted and successfully implemented by DMRC in the Delhi while carrying out works in the regulated/prohibited areas (ASI protected monuments) as well as close to public and private buildings and there is no damage to these structures due to the construction activities of Delhi Metro.

6.3.10 Air Pollution Control Measures

During the construction period, the impact on air quality will be mainly due to increase in Suspended Particulate Matter (SPM) along haul roads and emission from vehicles and construction machinery. Though an air quality during construction shows insignificant impact, nevertheless certain mitigation measures which shall be adopted to reduce the air pollution are presented below:

- The Contractor shall take all necessary precautions to minimise fugitive dust emissions from operations involving excavation, grading, and clearing of land and disposal of waste. He shall not allow emissions of fugitive dust from any transport during handling of materials, construction or storage activity. The emission should not remain visible in atmosphere beyond the property line of emission source for any prolonged period of time without notification to the Employer.
- The Contractor shall use construction equipment to minimise or control of air pollution. He shall maintain evidence of design and equipment to make these available for inspection by Employer.
- Contractor's transport vehicles and other equipment 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 measures including replacement, if required, so as to operate within permissible norms.
- The Contractor shall use cover for materials of dust generating like debris and soil being transported from construction sites. All trucks carrying loose material should be covered and loaded with sufficient free- board to avoid spills through the tailboard or sideboards.
- Contractor shall install barriers around the open construction sites before commencing the work.

- The temporary dumping areas shall be maintained by the Contractor at all times until excavate is re-utilised for backfilling wherever necessary or as directed by Employer. Dust control activities shall continue even during any work stoppage.
- The Contractor shall place material in a manner that will minimize dust production. Material shall be minimized each day and wetted, to minimize dust production. During dry weather, dust control measures must be used daily especially on windy, dry days to prevent any dust from blowing across the site perimeter.
- The Contractor shall sprinkle water at construction sites to suppress dust, during handling of excavation soil or debris or during demolition. The Contractor will make water sprinklers, water supply and water delivering equipment available at any time that it is required for dust control use. Dust screens will be used, as feasible when additional dust control measures are needed especially where the work is near sensitive receptors.
- The Contractor shall provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from work sites such as 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.

6.3.11 Noise Control Measures

There will be an increase in noise level in the tunnel due to construction and operation of the Metro corridors. However, noise levels in the core city are expected to go down. The increases in levels are marginal; hence local population will not be adversely affected. However the exposure of workers to high noise levels especially, near the engine, vent shaft etc. need to be minimized. This could be achieved by:

- Job rotation,
- Automation,
- Construction of permanent and temporary noise barriers,
- Re-route and regulate the traffic, a main source of noise,
- Use electric instead of diesel powered equipment,
- Use hydraulic tools instead of pneumatic tools,
- Acoustic enclosures should be provided for individual noise generating construction equipment,
- Scheduling of truck loading, unloading and hauling operation,
- Schedule work to avoid simultaneous activities
- Anti drumming floor and noise absorption material,
- Low speed compressor, blower and air conditioner,

- Mounting of under frame equipments on anti-vibration pad,
- Smooth and gradual control of door,
- Provision of GRP baffle on the via-duct for elimination of noise transmission,
- Provision of sound absorbing material in the supply duct and return grill of air conditioner,
- Sealing design to reduce the aspiration of noise through the gap in the sliding doors and piping holes, and
- Sound proof compartments/ control rooms etc.

The workers employed in high noise level area could be employed in low noise level areas and vice-versa from time to time. Automation of equipment and machineries, wherever possible, should be done to avoid continuous exposure of workers to noise. At work places, where automation of machineries is not possible or feasible, the workers exposed to noise should be provided with protective devices. Special acoustic enclosures should be provided for individual noise generating equipments, wherever possible.

Workers in those sections where periodic adjustment of equipment/machinery is necessary, should be provided with sound proof control rooms so that exposure to higher noise level is reduced. Effective measures should be taken during the construction phase to reduce the noise from various sources. The noise from air compressor can be reduced by fitting exhaust and intake mufflers.

Noise level from loading and unloading of construction materials can be reduced by usage of various types of cranes and placing materials on sand or sandy bag beds. The ballast-less track is supported on two layers of rubber pads to reduce track noise and ground vibrations. The concept of a “low-noise” electric locomotive must be adopted at a very early state of planning and must be followed up with detailed work throughout the project execution and operation. In addition, baffle walls as parapets will be constructed at up to the rail level so as to reduce sound levels.

6.3.12 Vibration Control Measures

The general assessment of the results indicates that, the proposed underground metro rail corridor project has the potential to create vibration impacts on the buildings adjacent to the alignment during the TBM operation. The vibration impact analysis has been conducted considering the worst case scenario. An actual vibration impact shall be carried out prior to the start of construction and during the construction on the basis of detailed soil investigation and TBM activities involved. Detailed geotechnical investigation is required prior to the tunnel construction. By adopting good construction practices, generation of vibration will be controlled during construction and operation.

Following measures to be taken during construction of tunnel, the contractor shall prepare a monitoring scheme prior to construction at such locations.

- Detailed vibration investigation should be carried out prior to construction at locations where the alignment is close to historical / heritage structures.
- Continuous vibration monitoring equipment shall be installed during construction.
- Vibration monitoring shall also be conducted inside as well as on the top of the building mainly for old structures and heritage buildings.
- Proper vibration mitigation measures to be taken during construction of tunnels and also during operation of metro rail.
- Pre-construction structural integrity inspections of historic and sensitive structures.
- The local residence staying in the buildings close to the proposed metro rail alignment shall be informed about the vibrations and to vacate the location if needed.
- Tunneling hours should be limited.
- Install supporting wall piles to reduce vibration and settlement impact,
- Information dissemination about the construction method, probable effects, quality control measures and precautions to be used.
- Inform the public about the project and potential vibration-related consequences, monitor and record vibration from the activities for sensitive receptors.

Vibration emanates from rail - wheel interaction and the same can be reduced by minimizing surface irregularities of wheel and rail, improving track geometry, providing elastic fastenings, and separation of rail seat assembly from the concrete plinth with insertion of resilient and shock absorbing pad.

While designing the track structure for Mass Rapid Transit System all the above points have been taken into consideration in the following ways:

- To prevent development of surface irregularities on the rail, a fairly heavy rail section of 60 kg/m, 90 UTS rail, supported at every 60 cms has been proposed. Further rail grinding at regular intervals by rail grinding machine and also lubrication of rail by vehicle mounted lubricator have been contemplated.

- Rails will be continuously welded and also will be laid to fine tolerances so that any noise/vibration on account of track geometry could be reduced.
- The vibration generated from rail-wheel interaction will be greatly absorbed by the elastic fastening system proposed to be used.

The lower vibration will be achieved by providing of bolster less type bogies having secondary air spring.

6.3.13 Traffic Diversion/ Management

Traffic is most likely to be affected during construction of metro rail project. Hence Traffic Diversion Plans are required in order to look for options and remedial measures so as to mitigate any traffic congestion situations arising out due to acquisition of road space during Metro construction. As the whole alignment of proposed metro is underground little disturbance will take place at the station locations only. Any reduction of road space during Metro construction results in constrained traffic flow. In order to retain satisfactory levels of traffic flow during the construction period; traffic management and engineering measures need to be taken. They can be road widening exercises, traffic segregation, one-way movements, traffic diversions on influence area roads, acquisition of service lanes, etc.

Various construction technologies are in place to ensure that traffic impedance is at the minimum. They are:

- 'Cut-and-Cover' method is proposed for construction of the underground segment. This means that the stretch between two points will have to be blocked during construction. However, temporary decking may be provided by blocking the road carriageway partially to permit traffic movement along the same stretch if possible.
- Wherever the stations are isolated, areas available around it should be utilized for road diversion purposes such as lay-byes and service roads.

Only temporary diversion plans will be required during construction of the Metro. At the onset, all encroachments from road ROW for stations and entry/exit will have to be removed. These encroachments vary from 'on-street' parking to informal activities. During the construction of works on underground section, it is proposed that temporary decking may be provided by blocking the road carriageway partially to permit 'through' as well as right-turning traffic movements. Total blockage of traffic along the underground section is not recommended due to non-availability of reasonably good alternate road network.

Keeping in view the future traffic growth and reduction of carriageway due to Metro construction, implementation of traffic management/diversion plans shall become inevitable for ensuring smooth traffic movement and similar traffic diversion plans shall be formulated and followed during the execution of project.

Traffic Management Guidelines: 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.

- All construction workers should be provided with high visibility jackets with reflective tapes as most of viaduct /tunneling and station works are 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.
- Warn the road user clearly and sufficiently in advance.
- Provide safe and clearly marked lanes for guiding road users.
- Provide safe and clearly marked buffer and work zones
- Provide adequate measures that control driver behavior through construction zones.
- The primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights.

The contractor will hire a transportation consultant that carry out the traffic survey and suggest alternative routes for smooth flow of traffic.

6.3.14 Soil Erosion Control

Soil Erosion during construction of proposed Metro rail will cause very little impact as whole the alignment is passing underground. The surface facilities and related transport will cause soil erosion. Prior to the start of the construction, the Contractor shall submit his schedules to the MMRDA for carrying out temporary and permanent erosion/sedimentation control works as are applicable for the items of clearing and grubbing, roadway and drainage excavation, embankment/sub-grade construction, bridges and other structures across water courses, pavement courses and shoulders. He shall also submit his proposed method of erosion/sedimentation control on service road and his plan for disposal of waste materials. Work shall not be started until the erosion/sedimentation control schedules and methods of operations for the applicable construction have been approved by the MMRDA.

The surface area of erodible earth material exposed by clearing and grubbing, excavation shall be limited to the extent practicable. The Contractor may be directed to provide immediate control measures to prevent soil erosion and sedimentation that will adversely affect construction operations, damage adjacent properties, or cause contamination of

nearby streams or other watercourses. Such work may involve the construction of temporary berms, dikes, sediment basins, slope drains and use of temporary mulches, fabrics, mats, seeding, or other control devices or methods as necessary to control erosion and sedimentation.

The Contractor shall be required to incorporate all permanent erosion and sedimentation control features into the project at the earliest practicable time as outlined in his accepted schedule to minimize the need for temporary erosion and sedimentation control measures.

Temporary erosion/sedimentation and pollution control measures will be used to control the phenomenon of erosion, sedimentation and pollution that may develop during normal construction practices, but may neither be foreseen during design stage nor associated with permanent control features on the Project. Under no conditions shall a large surface area of credible earth material be exposed at one time by clearing and grubbing or excavation without prior approval of the MMRDA.

Temporary erosion is sometimes caused due to the Contractor's negligence, carelessness or failure to install permanent controls. Sedimentation and pollution control measures then become necessary as a part of the work as scheduled or ordered by the MMRDA, and these shall be carried out at the Contractor's own expense. Temporary erosion, sedimentation and pollution control work, which is not attributed to the Contractor's negligence, carelessness or failure to install permanent controls, will be performed as ordered by the MMRDA.

6.3.15 Muck Disposal

Construction of underground metro projects is a specialised and complex task. Owing to paucity of space in the busy cities and for safety reasons, elaborate measures need to be adopted for collection, transfer, storage and disposal of excavated muck. Muck collection, transportation, disposal and its treatment need to be carried out in a systematic manner. Muck collection should be in containers from the dredging sites / places. These containers should be such that muck should not spill during movement to disposal site. The excavated muck will be first collected at temporary dumping ground and then transferred to disposal sites.

As discussed in Chapter-4, 5.40 Mm³ of muck will be disposed by adopting five options as described below.

- i **Use as fill material for JNPT Terminal 4:** It is informed that JNPT is proposing to build a new terminal (Terminal 4) over 200 ha in size. A large quantity of soil and graded material is required as fill material. Muck generated from Metro Line 3 works can be used as fill material for JNPT Terminal 4 construction; however the

timing for the construction of the terminal and metro will have to be synchronised. Further temporary jetties will have to be constructed along the metro alignment to transport the muck to JNPT Terminal 4 site.

- ii. **Use as fill material for minor ports in Maharashtra:** Several minor ports being developed within 300 km from Mumbai including one at Srivardhan by DAS Offshore who have indicated their willingness to use muck generated from Metro Line 3 for their construction. Apart from this MMB has informed of 5 other minor ports being developed close to Mumbai. This alternative also requires synchronisation of construction activities and temporary jetties will have to be constructed along the metro alignment to transport the muck to the ports.
- iii. **Filling of abandoned quarries in Raigad and Thane districts:** Raigad and Thane districts have several abandoned quarries of varying sizes; muck generated could be used to fill these quarries. These quarries are located far from the metro alignment (over 100 km) and require road transportation of the muck. There are 36 Nos of abandoned quarry sites in Raigad district and 59 Nos in Thane district. The details of abandoned quarry sites located in Raigad and Thane district is depicted in **Appendix 6.3**. The total area of abandoned quarry sites is worked out as 498 Ha and 1115 Ha located in Raigad and Thane district respectively.
- iv. **Recycle and Reuse:** Muck generated can be reused as aggregate material for road beds, ballast for railways, construction material and graded material can be used in concrete. The use can be decided only after thorough geotechnical investigation, testing of the muck and choice of TBM. This alternative will require land for setting up a plant to convert the muck to a useful form. It is proposed to appoint IIT – Bombay to study this alternative. A separate proposal in this regards is being moved.
- v. **Deep Sea Dumping:** There are a couple of deep sea dumping sites within 100 km from the Mumbai coast. Necessary clearances for use of these sites will be ensured before actually resorting to this. The Coordinates of deep sea dumping location is as indicated below.

1. 18°52'33.00"N, 72°45'6.60"E
2. 18°52'32.75"N, 72°45'38.99"E
3. 18°52'43.76"N, 72°45'39.02"E
4. 18°52'43.74"N, 72°45'6.60"E

Capacity of all the five options described above is approximately assessed for the disposal of muck as depicted in **Table 6.7**. Any one or more of the options will be selected on the basis of detailed investigation and getting the necessary clearances/permission from the concerned authority. A tentative cost estimate has been

worked out for disposal of muck as given in **Table 6.8**. Muck will be analyzed for heavy metals prior to their disposal at dumping site.

TABLE 6.7
CAPACITY OF MUCK DUMPING OPTIONS

| SR No. | Options | Capacity of dumping site in Mm ³ | Remarks |
|--------|---|---|--|
| 1. | JNPT Terminal 4 | 4.0 | Average depth of fill taken as 2.0 m |
| 2. | Ports/Jetties : at Rajauri Creek, Vill – Rohini, Dist. : Raigad | 7.8 | As Communicated by project proponent M/s Das Offshore Engg Pvt Limited |
| 3. | Abandoned Quarries (Raigad and Thane) | 16.13 | Average of fill taken as 1.0 m |
| 4 | Recycle and Reuse | - | Appointment of IIT – Bombay to study this alternative is in process |
| 5 | Deep Sea Dumping | - | Detailed investigation requires to be taken up |

TABLE 6.8
COST OF MUCK DISPOSAL

| SR. NO | PARTICULARS | COST (Rs. IN LAKHS) |
|--------------|---|---------------------|
| 1 | Environmental Study/Clearances (Lump sum) | 100.00 |
| 2 | Detailed Investigation (Lump Sum) | 300.00 |
| 3 | Transportation Cost @ 591 trips per day (Considering lead of 50 km) | 819.71 |
| 4 | Plantation & Beautification works (LS) | 85.00 |
| 5 | Miscellaneous | 130.47 |
| Total | | 1435.18 |

6.3.16 Draining of Water from Tunnel

In cut and cover type construction, continuous pumping is an economical alternative. The well point system is recommended for dewatering as the volume of water to be pumped out. The deep well system is adopted where the water table has to be lowered over a large depth in a small area. The deep wells can be installed either inside or outside the diaphragm walls or inside the cut.

A suitable piezometer is installed to monitor the water table constantly and to see how much lowering has been effectively done. The dewatering should not be stopped unless it is ensured from design calculations that the load of the constructed box component has reached a stage where it will be able to counter act the hydrostatic pressure from below. The dewatering can be achieved by:

- Leading the ground water to a sump by drains and pump out the water from the sump. To prevent loss of fines, inverted filter may have to be used.
- Dewatering as suggested above may not be effective in preventing sand flows. Lowering of the ground water by properly designed single or double stage well points will be effective in such cases.
- The construction of diaphragm walls of concrete along the side of channels, before the commencement of excavation will be required. The concrete walls are taken down to rest on bed rock or impervious strata or, in their absence, deep enough below the bottom of excavation, to serve as an effective cut off for the inflow of ground water into the proposed excavation. The trenches are made in lengths of 2.5 to 5m and kept continuously filled with a thiotropic material like Bentonite slurry, which has the effect of stabilising the trench and preventing any subsidence. As the excavation proceeds, concrete wall can be strutted mutually or anchored with surrounding rocks.
- During operation phase, seepage water will be drained along the side of walls (retaining). Proper drainage system need to be incorporated in design and implemented during construction phase.

The pumped water from sump wells will be put into storm water drain to avoid any load to waste water treatment plants. These storm water drains finally join natural existing streams/nallahs.

6.3.17 Water Supply, Sanitation and Solid Waste Management

The public health facilities, such as water supply, sanitation and toilets are much needed at the stations. Water should be treated before use up to WHO drinking water standards. The collection and safe disposal of human wastes are among the most important problems of environmental health. The safe sewage disposal systems would be provided.

Requirements of drinking water supply at station are about 6 KL/day. Raw water requirement for station is about 240-250 KL/Day. The water requirement at Depot will be 160 KLD. This shall be provided from municipal/ground water source.

Solid waste generated at underground station is about 0.5–1.0 m³/day. The maintenance of adequate sanitary facilities for temporarily storing refuse on the premises is considered a responsibility of the MMRDA project authorities. The storage containers for this purpose need to be designed. However it is suggested that the capacity of these containers should not exceed 50 litres and these should be equipped with side handles to facilitate

handling. To avoid odour and the accumulation of fly-supporting materials, garbage containers should be washed at frequent intervals. This should be collected and transported to local municipal bins for onward disposal to disposal site by municipality. Waste generated during and after construction will be disposed in accordance with relevant National and State laws and regulations.

6.3.18 Sensitive Receptors

As discussed in section 4.4.17, the impact on sensitive receptors is anticipated due to noise and vibration during construction. The management plan for noise & vibration control mentioned at section 6.2.10 & 6.2.11 will reduce the noise & vibration level substantially. Furthermore information will be communicated to the land owner of sensitive receptors about the project and potential noise & vibration generation due construction activities. The noise & vibration due to construction activities will be monitored and recorded at sensitive receptors. Construction contractor must provide a mechanism for receiving and responding to complaints arising due to impacts on sensitive receptors. Avoid nighttime construction activities near sensitive receptors if possible.

6.3.19 Electromagnetic Interference

Concrete structures are not good electrical earths and therefore, Earthing & Bonding of the power supply & traction system shall be designed in accordance with the latest standards EN50122-1, IEEE80, IS3043 etc. Two earth conductors-Overhead Protection cable (OPC) and Buried Earth Conductors are proposed to be laid along with underground tunnel and all the metallic structures, structural reinforcement, running rails etc will be connected to these conductors to form an equiv-potential surface & a least resistance path to the fault currents. The overhead protection cable will also provide protection against lightning to the 25 KV Rigid OHE on the underground and 25 KV OHE on the elevated viaduct. Detailed specification of equipment e.g. power cables, transformer, switchgear, E&M equipment etc shall be framed to reduce conducted or radiated emissions as per appropriate international standards. The metro system as a whole (trains, signalling & telecomm, traction power supply, E & M system etc) shall comply with the EMC requirements of international standards viz. EN50121, EN50123, IEC61000 series etc. As precautionary measures, the location of sub-station should be away from the dumping yards and sub-station should not be less than 3 km from the airport.

6.3.20 Management Plans for Depot

The depot is planned at Aarey Milk Colony (26.407 hectares) for the proposed metro project. The management plans for depot site includes:

- Water Supply,
- Oil Pollution Control,
- Sewage/Effluent Pollution Control,
- Solid Waste
- Surface Drainage,
- Green belt development,
- Rain water harvesting, and
- Recycling of treated waste water.

Water supply: About 160 KLD of water will be required for operation and functioning of depot. This could be either collected from Municipal Corporation or through boring tube well into the ground. The ground water will need treatment depending upon its use. Domestic and some of the industrial application, a Reverse Osmosis (RO) plant of 8 liter/minute capacity will be appropriate. The water treatment plant flow chart is given in **Figure 6.1**. The estimated cost of water supply plant is about **Rs.5.0 million**.

Oil Pollution Control: The oil tends to form scum in sedimentation chambers, clog fine screens, interfere with filtration and reduce the efficiency of treatment plants. Hence oil and grease removal tank has to be installed at initial stage of effluent treatments. Such tanks usually employ compressed air to coagulate the oil and grease and cause it to rise promptly to the surface. Compressed air may be applied through porous plates located in bottom of the tank. The tank may be designed for a detention period of 5 to 15 minutes. This accumulated oil and grease will be disposed off through approved re-cyclers.

Sewage/Effluent Pollution Control: About 130 KLD of sewage/effluent is likely to be generated at depot. The sewage could be treated up to the level so that it could be used for horticulture purpose in the campus and can also be discharged into the stream a process flow chart is presented in **Figure 6.2**. The estimated cost of sewage/effluent treatment plant is about **Rs.6.0 million**. This has to be treated as per the requirement of regulatory pollution control agency of the state (MPCB).

Solid Waste Disposal: About 1.8 Ton per month of solid waste will be generated from the Depot which will be taken by the cleaning contractor weekly and disposed to the Mumbai Municipal Corporation waste disposal sites.

Waste generated during and after construction will be disposed in accordance with relevant National and State laws and regulations.

Surface Drainage: The Storm water of the depot will be collected through the drain. Rain water harvesting pits are provided at different locations in the drains and for surplus storm water, the drainage system is connected to a nearby disposal site. The drainage costs have been included in project cost.

Green belt development: The greenbelt development / plantation in the depot area not only functions as landscape features resulting in harmonizing and amalgamating the physical features with surrounding environment but also acts as pollution sink / noise

barrier. In addition to augmenting present vegetation, it will also check soil erosion, make the ecosystem more diversified and functionally more stable, make the climate more conducive and restore balance. It is recommended to have a provision of **Rs 4 million** in the cost estimate for the green belt development. Treated sewage and effluent in the best combination should be used for green belt development.

Rain water harvesting: To conserve and augment the storage of groundwater, it has been proposed to construct roof top rainwater harvesting structure at the constructed depot site. Depot cum workshop area of 36,938 sq.m is available at Aarey Milk colony depot for roof top rain water harvesting. An annual average rainfall is 2000 mm, 202 KLD rain water will be harvested. The total recharge pit area of 8.5x8.5x3 will be required. A provision of **Rs. 1.5 million** has been kept in the cost estimate.

Recycling of treated waste water: Waste water generated at depot is proposed to be collected at ETP for treatment and recycled for horticulture work of the depot. About 105 KLD of treated waste water will be available for horticulture. The rest of treated water will be release to the Mithi River.

6.3.21 Training Programmes

The training programmes need to be conducted by the experts, for MRTS officers. These programmes could be extended for the local population for their active participation in the project implementation. Apart from training, such programme should include guidelines for safety, methods of disaster prevention, action required in case of emergency, fire protection, environmental risk analysis etc. Railways staffs are currently trained in railway operation and maintenance techniques. Additional training in above areas is required.

Two international training programme per year for 10 numbers of MMRC officers are proposed to acquire the latest know how about the construction, operation and maintenance of Metro rail. During the project construction period 100 numbers of MMRC staff will get the International training for which estimated cost will be **Rs. 216.00 Lakhs**. The overall cost involved for such programmes are presented in **Table 6.9**.

**TABLE 6.9
COST FOR TRAINING PROGRAMME**

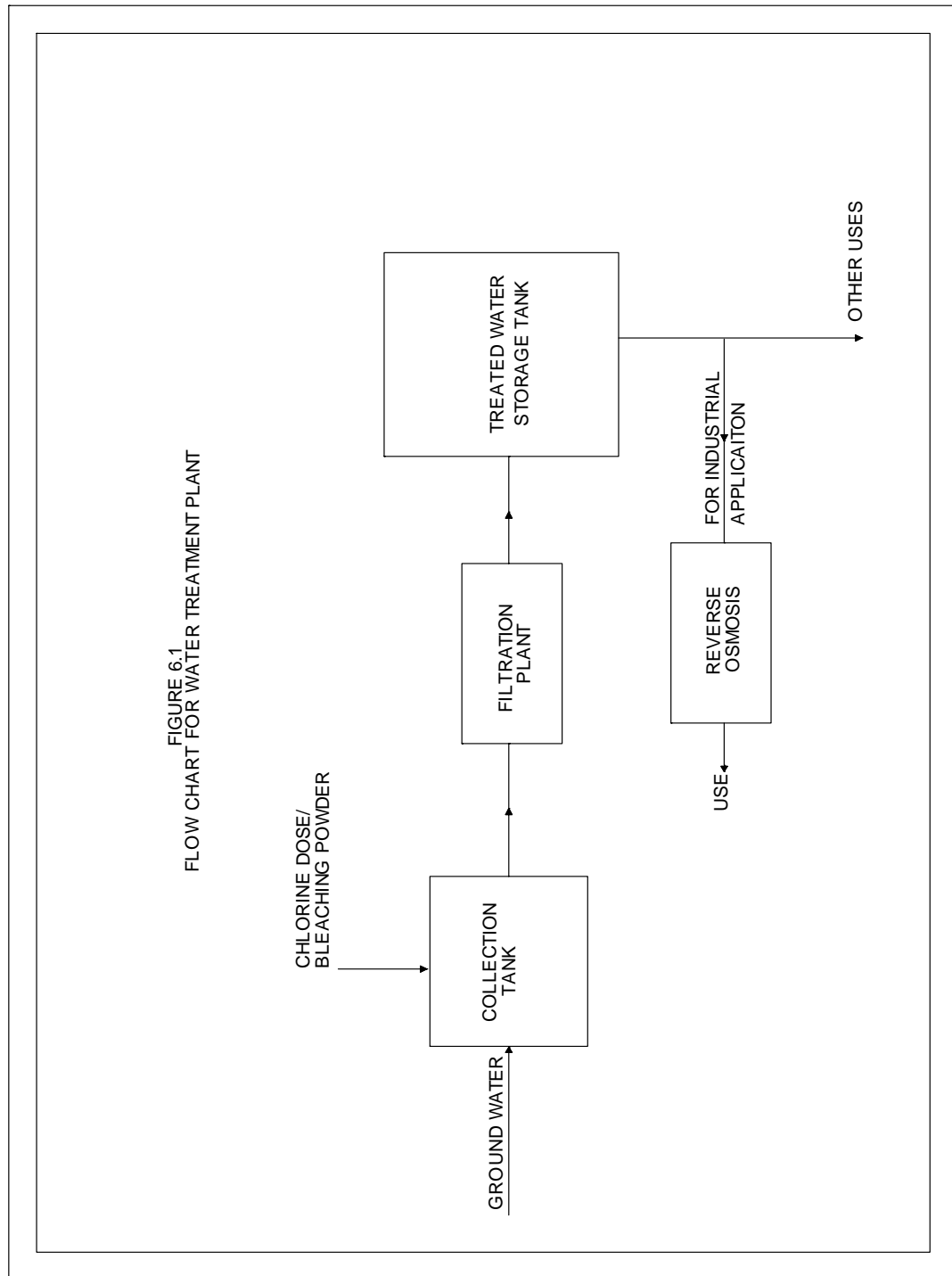
| S. NO | ITEM | COST (Rs) |
|--------------|--|-------------------|
| 1. | Curriculum Development and course preparation 2 months Rs.50000/month | 100,000 |
| 2. | 10 Extension Officer (1year) Rs.35, 000/month | 3500,000 |
| 3. | Instructor 20 sessions of 10 days each | 500,000 |
| 4. | Demonstration/Presentation Aids | 100,000 |
| 5. | Material etc | 200,000 |
| 6. | International Training for 100 MMRC staff | 216,00,000 |
| Total | | 22,000,000 |

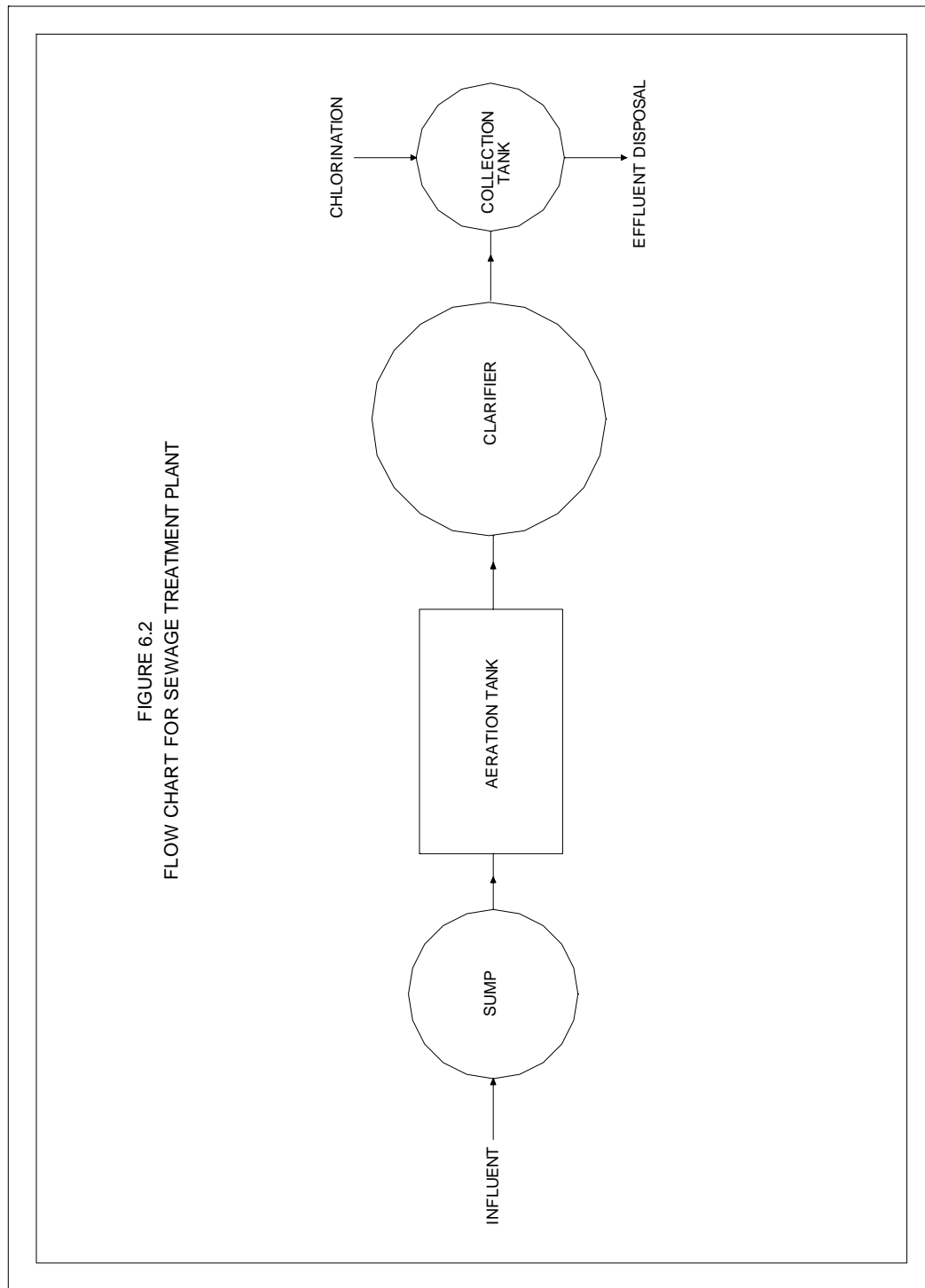
6.3.22 Environmental Enhancement Measures

In addition to mitigation measures adopted for negative impacts during construction and operation of the project, some of the measures for improvement of environment have been undertaken as described below:

- Landscaping & beautification
- Solar energy
- Renovation of Heritage structures & religious places
- Environmental awareness programmes
- Utility facilities to unprivileged people

The cost for environmental enhancement measures has been kept as **Rs. 85.00** Lakhs (Lump sum).





6.4 EMP Reporting Arrangement and Institutional Strengthening

Supervision involves periodic checking to ascertain whether activities are going according to the plans. It provides necessary feedback for project management team to keep the program on schedule. The supervision and reporting process with respect to implementation status of mitigation measures during construction will initiate from the contractor at the lowest rung who will report to the Project Implementation Agency (PIA) through the project management consultant.

During construction phase of the project, the EMP implementation comprises of the following key activities:

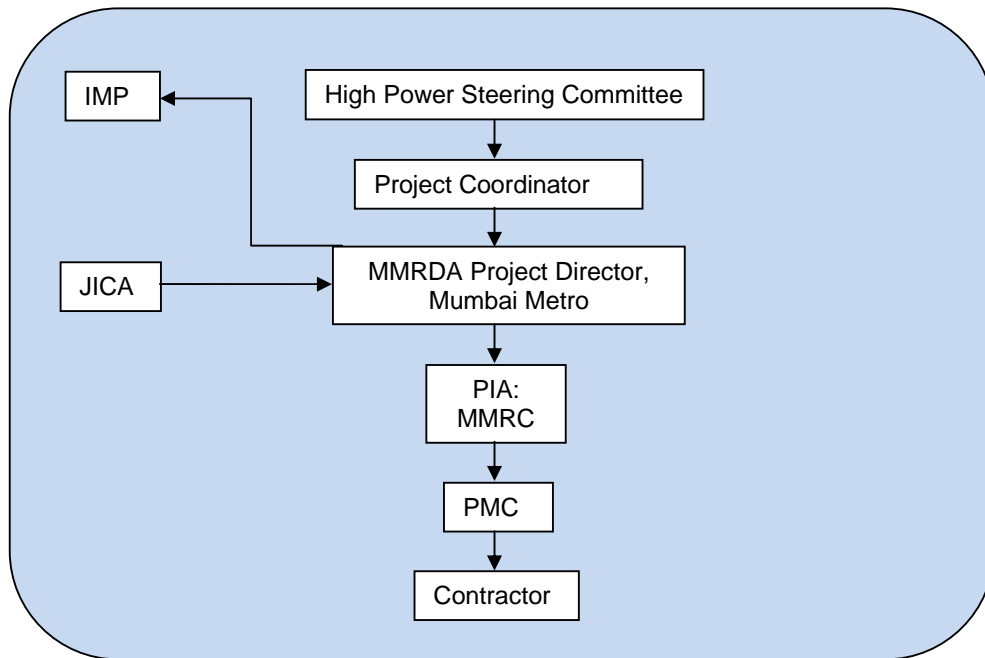
- Implementing various mitigation and enhancement measures within the time frame recommended
- Overseeing the implementing various mitigation and enhancement measures and fine tuning/advocating more measures, if needed, depending on site conditions;
- Project level monitoring of key performance indicators to evaluate the implementation of EMP measures at the recommended intervals.
- Periodical reporting of status of EMP implementation and monitoring results and key performance indicators and
- Constant evaluation of EMP measures implemented based on the data available from project level monitoring and status reports and providing directions accordingly.

These activities to be carried out by various agencies that will be involved in the implementation of Metro project. It is also to be noted that all these activities will be carried out concurrently or at regular intervals and at different duration and location. This makes it pertinent that all agencies involved work within a predefine setup. The coordination model proposed during construction and operation phases of sub project is presented in **Figure 6.3** and **Figure 6.4** respectively. The identified agencies and their sphere of work is presented in following section.

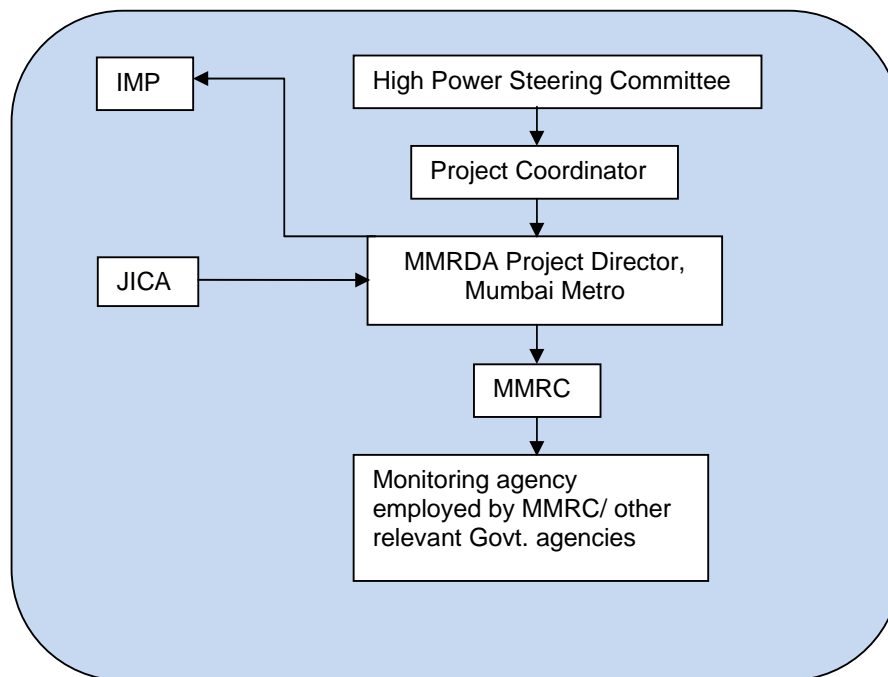
Project Implementation Agency (PIA)

The responsibility of implementing environmental mitigation measures lies with the PIA. PIA in this project will be Mumbai Metropolitan Regional Development Authority (MMRDA). The responsibility also includes various tasks such as notifying various affected parties such as the resident and commercial establishment, facilitate the relocation of people, notify other utility departments such as telephone, water supply, sewerage etc. which used the road for providing public utility services.

**FIGURE 6.3
INSTITUTIONAL MECHANISM FOR EMP IMPLEMENTATION
(CONSTRUCTION PHASE)**



**FIGURE 6.4
INSTITUTIONAL MECHANISM FOR EMP IMPLEMENTATION
(OPERATION PHASE)**



Project Management Consultant (PMC)

The PIA will get the EMP implanted through the Project Management Consultant (PMC) appointed for managing engineering and construction related activity. The PIA will delivered the responsibility of overseen the implementation of as per the contract agreement. In order to effectively discharge the duties PMC will have an environmental officer/expert in the project management unit. The environmental officer will work for a full time basis at the site office. The officer must possess experience in the environmental management of metro projects.

Project Contractor

Project contractor will implement the EMP measures, enhancement measures and measures as directed by PIA and PMC. The responsibility to implement the EMP measures will be built in to the contractual agreement. The contractor shall submit a report on compliance of environmental mitigation measures periodically to the PMC. The PMC will review and approve the environmental compliance report (ECR) submitted by the contractor and forward the ECR to PIA after approval. The PIL will then submit the ECR to Joint Project Director (JPD), environment which after review and monitoring will submit to Independent Monitoring Panels through the Project Director, MMRC. The Project Director accordingly submits report to the JICA.

MMRDA

MMRDA as an apex organization shall initiate coordinate process among the concern organization for EMP implementation. MMRDA shall take lead in

- Reviewing the progress of the project for the subsequent year- institution wise
- Reviewing and discussing the salient features of the report in the year on environmental aspects and their violations
- Organizing and coordinating training programs for all member organization

Independent Monitoring Panel (IMP)

This has been constituted by MMRDA with the objective to ensure that the Banks policies: related to social and environmental issues are followed. The Chairman of IMP is Ex-Chief Secretary to Government of Maharashtra. The other members are eminent environmental engineers, a senior Journalist and a leading Advocate. The IMP will meet periodically to review the periodical reports, environmental compliance report etc.

6.5 DISASTER MANAGEMENT

Disaster is an unexpected event due to sudden failure of the system, external threats, internal disturbances, earthquakes, fire and accidents. The first step is to identify the causes which develop/ pose unexpected danger to the structural integrity of Metro tunnel.

The potential causes are excessive load, cracks, failure and malfunctioning of sensing instruments, accident, etc. These need to be looked into with care.

6.5.1 Preventive Action

Once the likelihood of a disaster is suspected, action has to be initiated to prevent a failure. Engineers responsible for preventive action should be aware of availability of repair equipments, materials, labour and expertise for use during emergency.

6.5.2 Reporting Procedures

The level at which a situation will be termed a disaster shall be specified. This shall include the stage at which the surveillance requirements should be increased both in frequency and details.

The Engineer-in-Chief should notify the officer for the following information:

- Exit points for the public,
- Safety areas in the tunnel, and
- Nearest medical facilities.

6.5.3 Communication System

An efficient communication system is absolutely essential for the success of any disaster management plan. This has to be worked out in consultation with local authorities. More often, the entire communication system gets disrupted when a disaster occurs. The damage areas need to be clearly identified and provided with temporary and full proof communication system.

6.5.4 Emergency Action Committee

To ensure coordinated action, an Emergency Action Committee should be constituted. MD MMRC will be the Chairman of this Committee. The committee may comprise of:

- Head of operations,
- Head of technical services
- Head of security,
- Fire brigade
- Police representatives and
- NGO

Emergency Action Committee will prepare the evacuation plan and procedures for implementation based on local needs and facilities available. The plan should include:

- Demarcation of the areas to be evacuated with priorities,
- Safe route to be used, adequacy of transport for evacuation, and traffic control,
- Safe area and shelters,
- Security of property left behind in the evacuated areas,
- Functions and responsibilities of various members of evacuation teams, and
- Setting up of joint control room.

All personnel involved in the Emergency Action Plan should be thoroughly familiar with all the elements of the plan and their responsibilities. They should be trained through drills for the Emergency Action Plan. The staff at the site should be trained for problem detection, evaluation and emergency remedial measures. Individual responsibility to handle the segments in emergency plan must be allotted.

Success of an emergency plan depends on public participation, their response to warning notifications and timely action. Public has to be educated on the hazards and key role in disaster mitigation by helping in the planned evacuation and rescue operations.

It is essential to communicate by whom and how a declared emergency will be terminated. There should be proper notification to the public on de-alert signals regarding termination of the emergency. The notification should be clear so that the evacuees know precisely what to do when re-entering or approaching the affected areas.

6.6 EMERGENCY MEASURES

The emergency measures are adopted to avoid any failure in the system such as lights, fire, means of escape, ventilation shafts etc. The aim of Emergency Action Plan is to identify areas, population and structures likely to be affected due to a catastrophic event of accident. The action plan should also include preventive action, notification, warning procedures and co-ordination among various relief authorities. These are discussed in following sections.

6.6.1 Emergency Lighting

The emergency lights operated on battery power should be provided at each station. The battery system should supply power to at least 25% of the lights at the station, platforms, tunnels/viaducts for a period of 2 hours. The underground station should have transformer at each end of the platform. Both the transformers need to be kept energized and should feed independently alternate rows of lights so that in case of failure of one transformer, there will not be complete darkness. The tunnels need to be provided with fluorescent incandescent lamps at a spacing of 20 m.

6.6.2 Fire Protection

The building materials should be of appropriate fire resistance standard. For underground structures the fire resistance period should be at least 4 hours, and 2 hours for surface or over head structures. Wood shall not be used for any purpose, excluding artificial wood products, which are flame resistant. The materials which have zero surface burning characteristics need to be used. The electrical systems shall be provided with automatic circuit breakers activated by the rise of current as well as activated by over current. The design of a station will include provision for the following:

- Fire prevention measures,
- Fire control measures,
- Fire detection systems,
- Means of escape,
- Access for fireman, and
- Means of fire fighting.

Accumulations of refuse of inflammable material like paper, plastic cartons constitute a major fire hazards and should not be permitted. Smoking should be strictly prohibited at all locations of MRTS.

All aspects of fire prevention and control will be dealt in close collaboration with the city fire fighting authority. Smoke control will be achieved by the following means:

- Downstand bulkheads of a minimum depth of 600 mm to provide smoke containment. These will be provided around openings for escalators, lifts and stairs in underground stations,
- In underground stations the ventilation system will be designed to extract smoke in the event of fire, and

A minimum of 30 minutes supply of water is to be assured in the case of fire. The pumps/overhead tanks shall have the capacity to discharge the water at the rate of 1100 litres per minute at a head of 21 m at nozzle mouth.

The storage capacity in an underground or overhead tank may be divided into two parts i.e. dead storage and running storage. Fire fighting pumps shall be provided with a diesel pump as a standby arrangement, in case of power failure.

Fire of electrical origin, water cannot be used until the electric system has been made dead and earthen. For electrical fires, non-aqueous agents like ABC Power ChloroBromo Methane or CO₂ gas are utilized for fire fighting. Fire extinguishers with these agents shall be liberally provided at static installations and on the rolling stock.

Generally there are often more casualties from smoke inhalation than from burning. Smoke need to be transported away from the site of the fire. In order to achieve this, fresh air has to be introduced into the underground section and exhaust gases should be sucked out from other section.

Openings, including ducts and passages, between MRTS property and any adjoining structures which allow free access into the MRTS property will be protected by fire doors, fire shutters, fire dampers etc. as appropriate. Fire detection and alarm systems will be provided as per the prevailing state of art technology.

A. Fire Prevention and Safety Measures

Fire prevention measures will be designed and implemented to minimize the risk of outbreak of fire by appropriate choice, location and installation of various materials and equipment. In stations planning, potential sources of fire can be reduced by:

i. Fire Prevention

- Use of non-combustible or smoke retardant materials where possible,
- Rolling stock is provided with fire retarding materials, low smoke zero halogen type electric cable is also provide,
- Provision of layout which permits ease of maintenance for equipment and cleaning of the station premises,
- Provision of special storage spaces for combustible materials such as paint and oil,
- Prohibition of smoking in fire prone areas,
- Provision of cigarette and litter bins, and
- Good housekeeping.

ii. Safety

Following provisions will be required from fire safety point of view:

- Automatic sprinkler/detection system to be provided if floor area exceeds 750 sq.m
- One wet riser-cum-down comer per 1000 sqm floor area with static underground storage tank, overhead tanks and pumps of suitable capacity with hydrants, first-aid reel, etc.
- Portable fire non-aqueous extinguishers of Carbon di Oxide, chemical dry powder etc. at suitable places.
- Automatic smokes venting facilities.
- Two separate means of exit shall be provided, if more than 10 persons are working and the area exceeds 1400 sq.m

- Fire resisting doors shall be provided at appropriate places along the escape routes to prevent spread of fire and smoke.
- The travel distance for fire escape shall not exceed 20 m where escape is available in more than one direction; the distance could be upto 40 m.

B. Fire Alarm and Detection System

A complete fire detection system with equipment complying with the requirements of Mumbai Fire Services shall be provided through out each station and ancillary buildings including entrance passageways, subways and adits etc. to give visual and audible indication of alarm conditions actuated by the operation of break glass contact or fire sensors e.g. detector heads, linear heat detecting cables etc. The system shall be operated from 24 V DC Power sources.

Manually operated call points shall be provided at every hydrant and nose reel points, station head wall, tail wall and other locations. Alarm bells shall be installed in each plant room complex at both platform and concourse level and shall be clearly audible at all points in the room/area.

Beam detector or heat detector shall be installed at roof level, ceiling and floor cavity, whilst linear detecting cables shall be installed in under platform cable ducts and cable shafts.

Smoke probe units shall be installed in rooms/compartments. When an alarm point is operated, the fire pump shall start to operate automatically. A station fire control and indicating panel shall be provided/ installed in the station controllers room, for the control, indication and monitoring of the whole detection and fire fighting systems. While designing the fire fighting system, the zone of Mumbai Fire Services shall be taken into account for linking with the same.

C. Fire Control Measures

Control of the spread of fire and smoke will be achieved by partition of fire risk areas, planning for smoke extraction, and arrangement for smoke containment. Partition is aimed at limiting the extent of a fire. The openings must be capable of being sealed in the event of fire. With the exception of station public areas, a fire compartment will not exceed 1500 m². Partition of the public areas in stations is not practicable for operational reasons. The fire resistance period of this separated area should be about 3 hours.

D. Access for Fireman

A secondary access to the station, not used by passengers for evacuation, shall be available to fireman when the need arises. The entry point shall be easily accessible

from the road. Access shall be available to all levels of the station. The minimum width of the stairs is 1.0 m and maximum height should not exceed 60 cm.

6.6.3 Ventilation Shafts

The Environmental Control system for underground stations requires ventilation openings between various plants, plant rooms and the atmosphere. Shafts are required for exhaust air, fresh air intake and draft relief. Ventilation shafts will be provided at each station.

6.6.4 Emergency Door

The rolling stock is provided with emergency doors at both ends of the cab to ensure directed evacuation of passengers in case of any emergency including fire in the train.

6.6 SUMMARY OF ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The environmental impacts stemming out of the proposed project can be mitigated with simple set of measures, dealing with careful planning and designing of the metro alignment and structures. Adequate provision of environmental clauses in work contracts and efficient contract management will eliminate or reduce significantly all possible problems. A common problem encountered during implementation of environmental management plans of such projects is lack of environmental awareness among engineers and managers concerned with day to day construction activities, which can be solved through regular environmental training programs. A set of preliminary EMP is presented in **Table 6.10**, which defines actions to be undertaken during the design stage, pre-construction, construction and operation stage of the project. The effectiveness of environmental considerations will, however, depend on appropriate inclusion of these in the work contracts.

The major concern during the construction stage is that the contractors, due to lack of enforcement, would not practise good environmental sanitation (housekeeping), may intend to get unauthorized use of the easily available natural resources and other available infrastructure like roads and water resources. This would result in degradation of ambient air quality, water resources and land environment around the construction sites and workers camp. Improper management of earthwork and bridge construction activities would disrupt the natural drainage and increase soil erosion. Improper management may result in spillage of explosives into the hands of unsocial elements. Finally the implementation of the mitigation actions requires that the project implementation unit would record an end-of-construction mitigation checklist, before releasing the final payment of any work contract.

In addition to that MMRDA, should prepare and establish Environmental and Health Policy and Procedures and that should become an integral part of contract document.

Operational phase mitigation would involve good environmental sanitation (housekeeping) practice at metro establishments including effective solid waste collection and disposal, wastewater disposal, upbringing of plantations and green area. Protection of earth slopes in landslide prone area would be a very important task. During the operation period, the metro operating unit will be required to confirm receipt of the construction period mitigation report through the PIU and prepare and follow on timetable of actions.

**TABLE 6.10
ENVIRONMENTAL MANAGEMENT ACTION PLAN (EMP)**

| Environmental Impact | Mitigation Measures Taken or To Be Taken | Time Frame | Implementing Organization | Responsible Organization |
|---|--|---|----------------------------------|---------------------------------|
| DESIGN PHASE | | | | |
| Metro Alignment | The proposed corridor alignment was selected to minimise the land disturbance to avoid archaeological sites, temples and other environmentally sensitive areas. | During Design | DPR and design consultant | PIU |
| Cultural Heritage | Avoided by adjustment of alignment. | During Design | DPR and design consultant | PIU |
| Inadequate design provision for safety against seismological hazard | Make sure that design provides for safety of structures against worst combination of forces in the probability of an earthquake likely to occur in seismic zone-III. | DPR and detailed design stage | DPR and design consultant | PIU |
| PRE –CONSTRUCTION STAGE | | | | |
| Water requirement | The requirement of water shall be for construction purpose etc., shall be planned and shall be arranged in order to avoid digging of Tube wells. | Pre construction stage | Contractor | PIU/EMP implementing agency |
| Disposal of final treated effluent from treatment plat | Options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact of receiving bodies. As far as possible zero discharge rules may be adopted. | During design stage / and pre construction of treatment plant | Contractor | PIU/EMP implementing agency |
| CONSTRUCTION PHASE | | | | |
| Environmental Management and Monitoring | This will include institutional requirements, training, environmental management and monitoring | During and after construction | Contractor | PIU/EMP implementing agency |
| Dust | Water should be sprayed during construction phase, wherever it is required to avoid dust. Vehicles delivering materials should be | During construction | Contractor | PIU/EMP implementing agency |

| Environmental Impact | Mitigation Measures Taken or To Be Taken | Time Frame | Implementing Organization | Responsible Organization |
|--|---|---|---------------------------|-----------------------------|
| | covered to reduce spills and dust blowing off the load. | | | |
| Air Pollution | Vehicles and machinery are to be regularly maintained so that emissions conform to National and State AAQ Standards. | Beginning with and continuing throughout construction | Contractor | PIU/EMP implementing agency |
| Equipment Selection maintenance and operation | Construction plants and equipment will meet recognized international standards for emissions and will be maintained and operated in a manner that ensures relevant air, noise, and discharge regulations are met. | During construction | Contractor | PIU/EMP implementing agency |
| Noise | Workers in vicinity of strong noise will wear earplugs and their working time should be limited as a safety measure. At construction sites within 150m of sensitive receptors construction will be stopped from 22:00 to 06:00. Noise barriers (Stone walls and plantation) for silence zones including schools and hospitals. | Beginning and through construction | Contractor | PIU/EMP implementing agency |
| Vibration | The vibration level limits at work sites adjacent to the alignment shall conform to the permitted values of peak particle velocity. | Beginning and through construction | Contractor | PIU/EMP implementing agency |
| WATER | | | | |
| Contamination from Wastes | All justifiable measures will be taken to prevent the wastewater produced in construction from entering directly into rivers and irrigation system | Throughout construction period | Contractor | PIU/EMP implementing agency |
| Wastage of water | Measures shall be taken to avoid misuse of water. Construction agency shall be instructed accordingly to follow strict procedures while using the water for construction and drinking purpose. | Beginning with and continuing throughout construction | Contractor | PIU/EMP implementing agency |
| Sewage disposal during construction at Service Centres | A minimum distance of any sewage or toilet facility from water sources should be 200 metres | Throughout construction period | Contractor | PIU/EMP implementing agency |
| Sanitation and Waste Disposal in Construction Camps | Sufficient measures will be taken in the construction camps, i.e. provision of garbage tank and sanitation facilities. Waste in septic tanks will be cleared periodically. | Before and during building of construction camps | Contractor | PIU/EMP implementing agency |

| Environmental Impact | Mitigation Measures Taken or To Be Taken | Time Frame | Implementing Organization | Responsible Organization |
|---|---|---|---------------------------|-----------------------------|
| | <p>Drinking water will meet Indian National Standards.</p> <p>Garbage will be collected in a tank and disposed of daily. Special attention shall be paid to the sanitary condition of camps.</p> <p>Camps will be located at a minimum distance of 200 m from water sources.</p> | | | |
| SOIL | | | | |
| Quarrying | <p>Quarrying will be carried out at approved and licensed quarries only.</p> <p>Soil parameters of the dumping site should be monitored.</p> | During construction | Contractor | PIU/EMP implementing agency |
| FLORA AND FAUNA | | | | |
| Loss of trees and Plantation | Two times trees will be planted against every tree cut as per norms. Plantation of trees as per Maharashtra (Urban Areas) Protection and Preservation of Trees Act 1975. More importance should be given for transplantation of tree rather than cut. | After completion of construction activities | Forest Department | Forest Department |
| SOCIAL | | | | |
| Traffic jams and congestion | If there are traffic jams during construction, measures should be taken to relieve the congestion with the co-ordination of transportation and traffic police department | During construction | Contractor | PIU/ Traffic department |
| Safety with vehicles, people and livestock and signage | <ul style="list-style-type: none"> Safety education and fines. Allow for adequate traffic flow around construction areas Provide adequate signage, barriers and flag persons for safety precautions. Communicate to the public through radio, TV & newspaper announcements regarding the scope and timeframe of projects, as well as certain construction activities causing disruptions or access restrictions | During construction | Contractor | PIU/ Traffic department |
| Increase in disease Water-borne Insect-borne Communicable diseases | <ul style="list-style-type: none"> Make certain that there is good drainage at all construction areas, to avoid creation of stagnant water bodies. Provide adequate sanitation and waste disposal at construction camps. Provide adequate health care for | <p>During construction</p> <p>At start-up</p> <p>Throughout</p> | Contractor | PIU/EMP implementing agency |

| Environmental Impact | Mitigation Measures Taken or To Be Taken | Time Frame | Implementing Organization | Responsible Organization |
|--|--|---|-----------------------------|-----------------------------|
| | workers and locate camps away from vulnerable groups | construction | | |
| Location of camp, depot and storage areas | Location of camps, depot and storage areas shall be as per the contract specifications. | Throughout construction | Contractor | PIU/EMP implementing agency |
| OPERATION PHASE | | | | |
| Noise and Vibration | Suitable measures should be considered where warranted. The public shall be educated about the regulations of noise and vibration pollution and its implications. | After completion of construction | PIU/EMP implementing agency | PIU/EMP implementing agency |
| WATER | | | | |
| Oil pollution | Suitable treatment shall be taken for treatment of oil in depot areas before discharging the wastewater. | During operation of the treatment plant | PIU/EMP implementing agency | PIU/EMP implementing agency |
| Disposal of final treated effluent from treatment plant. | Options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact of receiving bodies. As far as possible zero discharge rules may be adopted. | During operation of the treatment plant | PIU/EMP implementing agency | PIU/EMP implementing agency |

Appendix 6.1

Permission letter for removal of trees

Address of the office of the applicant

No.

Date :

To,
The Tree Authority
Municipal Corporation of Greater Mumbai,
Office of the Supdt. of Gardens/Tree Officers,
Veermata Jijabai Bhosale Udyan,
Dr. Ambedkar Road, Byculla(East),
Mumbai-400 027.

Sub : Request for grant of permission for removal of
trees coming in the proposed construction of
_____ at _____

I, the undersigned, Shri/Smt./Kum. _____ as required under section 8 of the Maharashtra (Urban Areas) Protection & Preservation of Trees Act 1975, as modified upto 9th June 2004, submit herewith the details of all the existing trees on the plot alongwith the trees required to be removed with due reasons thereon. The same is duly certified by a qualified Horticulturist and the certificate of the same is attached herewith/duly certified by the Horticultural Assistant of the ward.

Alongwith this application, I am also submitting the following.

- 1) Detail address of the site with landmark.
- 2) One copy of complete set of plans, drawings etc. of the proposed construction, approved by the Competent Authority and duly certified by the concerned architect / concerned authority as true copy.
- 3) Three copies of ground floor plan of proposed construction in case of building, approved by the Competent Authority and duly certified by the concerned authority as true copy. On this plan, all the existing trees are marked correctly as per their location at site and numbered serially. Similarly, out of the existing trees, trees proposed to be removed are marked in red colour, to be retained in green colour. Similarly the trees proposed to be newly planted are marked in yellow colour.
- 4) Three copies of lay out/block plan of proposed construction, approved by the Competent Authority and duly certified by the concerned authority as true copy. On this plan, all the existing trees are marked correctly as per their location at site and numbered serially. Similarly, out of the existing trees, trees proposed to be removed are marked in red colour, to be retained in green colour. Similarly, the trees proposed to be newly planted are marked in yellow colour. Similarly, marked all actual alignment of the works on the plan in different colours such as existing road line, proposed widening of the road, bridges, service road line, footpath, storm water drain etc. and also demarcated at site.

.. 2 ..

.. 2 ..

- 5) The copy of the plan certified by C.F.O. alongwith a copy of letter from him as requirement for removal of trees in the case of building.
- 6) All existing trees on the plot/site are numerically & serially numbered at site with black and white enamel paint.

The details of existing trees along with proposed requirement is as follows:

| Sr.No. of the tree | Kind / Species of the tree | Whether to be removed or retained | Detail reason for removal or retention |
|--------------------|----------------------------|-----------------------------------|--|
| | | | |
| | | | |
| | | | |
| | | | |

The requisite no. of trees will be planted as per the norms of Tree Authority i.e. in open space 2 trees per 100 sq.mtr. and in R.G.Area 5 trees per 100 sq.mtr. and care will be taken for proper growth of the trees and will give report to the Tree Officer about the condition of the trees once in six months for a period of 3 years.

I/We will not cut/transplant the trees for which the permission is granted by the Tree Authority until 15 days after permission is given to fell a tree and will plant two (2) new trees in lieu of one tree permitted to fell within 30 days from the date of tree/trees is/are felled and immediately report the same. A report regarding their proper growth and condition will be submitted once in six months for a period of three (3) years.

I hereby agree to pay requisite process fee for processing the proposal and necessary deposit. (This applies to the applicant other than Municipal Corporation of Greater Mumbai)

Tree Authority is requested to grant the permission for removal of trees as mentioned above at the earliest.

Thanking you,

Yours faithfully,

Full Name of the Applicant

Seal / Rubber Stamp

Appendix 6.2

Format Letter for NOC (Mumbai Heritage Conservation Committee)

FORMAT OF SUBMISSIONS FOR MHCC NOC

To be submitted by the Applicant in A3/A4 size spiral bind report – A copy to be circulated to all members for comments).

A. ON THE COVER PAGE (To be filled in by the Secretarial Staff or the applicant):

| | | | |
|----|--|---|--|
| 1) | Name of the Structure | : | |
| 2) | Sr.No. of Listing | : | |
| 3) | Grade / name of Precinct and criteria for grading / listing | : | |
| 4) | Name of the Applicant, Architect & Structural Engineer | : | |
| | Proposal for: i) Restoration ii) Skillful repairs & maintenance iii) Additions & alterations and extensions. iv) Development & Reconstruction. v) Change of user vi) Interior work v) Any other not covered by above. | : | |
| 5) | Checklist of drawings a) complete..... b) Incomplete..... (to be attested by MHCC secretarial staff) | : | |
| 7) | Submitted on (dt.) | : | |
| 8) | Revision | : | |
| 9) | Whether the proposal was considered by M.H.C.C. earlier & if yes details thereof. | : | |

B. DETAILS OF THE PROPOSAL (To be submitted by the applicant):

| | |
|----|--|
| 1) | TEXT |
| 1 | Brief description of the structure (physical attributes, architectural features and style, if any) |
| 2 | Identify the cultural significance for which it is listed (if its known or else copy the criteria /classification from listing) |
| 3 | Photomontage; of immediate surrounding area, the building (facades of all sides), interiors, and overall view from adjoining property or across the road. Archival snaps and Google Earth aerial snap :- Furnish whatever is applicable & appropriate. |
| 4 | Clear Description of Intervention being done (as specified in A5) |
| 5 | Architects appointment letter or Clients letter authorising the architect to represent on his behalf to MHCC. |

| | |
|-----|--|
| ii) | DRAWINGS (for all categories of proposals) : Plans , elevations , sections etc. showing clearly the entire scope of proposal. |
| | FOR REPAIRS / RESTORATION / STRENGTHENING : |
| i | Location plan: With surrounding buildings, street nodes etc. and the site/bldg./structure in question with an appropriate scale. |
| ii | Block plan: Details of site with its immediate surroundings + location of trees at site. |
| iii | Floor plans: With interventions and specifications marked on it. |
| iv | Roof plan (tilled roof, water tank, flat terraces etc. all shown) |
| v | Sections. With interventions and specifications marked on it (essential if major |

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| | |
|-----|--|
| | interventions are required) |
| vi | Elevations : With interventions and specifications marked on it |
| vii | Structural strengthening details alongwith drawings and typical calculation (if major interventions are envisaged) |

NOTE : In respect of iii) to vii) please specify the present condition or distress and the details of proposed repairs/ reconstruction /renovation in the same plan (of the set of plans). However, as it is advisable to give clarity to the proposal, indicate the distress in one plan and the proposed repairs/renovation/reconstruction in another plan. Submit a set of plans showing all the facades of the structure or structures, if they are more than one.

| | FOR EXTENSION / RECONSTRUCTION / DEVELOPMENT : |
|-----|--|
| i | Detailed Elevation (in different ink) with adjoining buildings shown highlighting height, mass, volume and architectural details in another ink. |
| ii | Axonometric view and site or block model if so desired. |
| iii | Details of interventions & specifications shown in drawings. |
| iv | All strengthening & Structural drawings with typical calculations. |

| C. | ADDITIONAL DOCUMENTS : |
|-----|--|
| i | Copy of D.P. Remark |
| ii | Copy of NOC / Remarks from Traffic & Coordination Dept. |
| iii | Copy of NOC from MHADA / Repairs Board /..... |
| iv | List of concessions in DCR; sought from the MHCC (eg. Open space concession etc.). |
| v | Copy of Lease Agreement / Govt. Covenant / Collectors NOC |
| vi | Any other..... |

| D. | FOR SEEKING NOC FOR THE COMPLETED WORK : |
|-----|--|
| i | Copy of previous approval /NOC from the MHCC. |
| ii | Copy of IOD / C.C.. |
| iii | Set of drawings showing the plans as constructed at site alongside the plans previously approved (if there are any deviations / modifications) |
| iv | List of deviations / modifications carried out other than the plans approved by the MHCC |
| v | Photographs of the completed work. |

Dy. M.A. (D.P.)

Appendix-6.3
DETAILS OF ABANDONED QUARRY SITES IN RAIGAD AND THANE DISTRICT

| RAIGAD DISTRICT | | | | | | Remarks |
|------------------------|---------------|---------------------|-----------------------|----------------------|------------------|----------------------------|
| Sr. No | Taluka | Village name | Name of quarry | Sector number | Area (ha) | |
| 1 | Mangaon | Indapur | PWD mine | 277 | 6 | |
| 2 | Mangaon | Tilore | PWD mine | 98c | 13 | |
| 3 | Mangaon | Tilore | PWD mine | 98b | 10 | |
| 4 | Mangaon | Potnare | PWD mine | 248 | 3 | |
| 5 | Mangaon | Makdi | PWD mine | 168 | 6 | |
| 6 | Mangaon | Koshumbal | PWD mine | 189 | 20 | |
| 7 | Mangaon | Tale | PWD mine | 93 | 30 | |
| 8 | Mangaon | Ratwad | PWD mine | 42 | 9 | |
| 9 | Mangaon | Ratwad | PWD mine | 88 | 7 | |
| 10 | Mangaon | Ratwad | PWD mine | 423 | 4 | |
| 11 | Mangaon | Bhuvan | PWD mine | 198 | 13 | |
| 12 | Mangaon | Bhuvan | PWD mine | 205 | 13 | |
| 13 | Mangaon | Bhuvan | PWD mine | 324 | 14 | |
| 14 | Mangaon | Niraj | PWD mine | 455 | 17 | |
| 15 | Mangaon | Niraj | PWD mine | 456 | 18 | |
| 16 | Mangaon | Vavediwali | PWD mine | 97 | 42 | |
| 17 | Mangaon | Vavediwali | PWD mine | 117 | 13 | |
| 18 | Mangaon | Repoli | PWD mine | 301 | 9 | |
| 19 | Mangaon | Repoli | PWD mine | 137 | 13 | |
| 20 | Mangaon | Repoli | PWD mine | 117 | 12 | |
| 21 | Mangaon | Repoli | PWD mine | 112 | 13 | |
| 22 | Mangaon | Garol | PWD mine | 63b | 25 | |
| 23 | Mangaon | Kalmage | PWD mine | 70a | 32 | |
| 24 | Mangaon | Vinchvali | PWD mine | 140 | 4 | |
| 25 | Mangaon | Khanpale | PWD mine | 426 | 4 | |
| 26 | Mangaon | Khanpale | PWD mine | 429 | 15 | |
| 27 | Panvel | Bhokarpada | Stone mine | 18 | 15 | |
| 28 | Panvel | Bhokarpada | Stone mine | 121 | 10 | |
| 29 | Panvel | Barvai | Stone mine | 76 | 9 | Entrance road not existing |
| 30 | Panvel | Barvai | Stone mine | 94 | 5 | Entrance road not existing |
| 31 | Panvel | Barvai | Stone mine | 132 | 49 | Entrance road not existing |
| 32 | Panvel | Barvai | Stone mine | 133 | 6 | Water line crossing |
| 33 | Panvel | Khanavale | Stone mine | 7 | 9 | |
| 34 | Panvel | Khanavale | Stone mine | 10 | 13 | |
| 35 | Panvel | Khanavale | Stone mine | 135 | 9 | Entrance road not existing |
| 36 | Panvel | Khanavale | Stone mine | 143 | 8 | Entrance road not existing |
| Total | | | | | 498 | |

| THANE DISTRICT | | | | | |
|-----------------------|---------------|---------------------|-----------------------|----------------------|------------------|
| Sr. No | Taluka | Village name | Name of quarry | Sector number | Area (ha) |
| 1 | Bhiwandi | Kaneri | Stone mine | 58 | 9 |
| 2 | Bhiwandi | Kaneri | Stone mine | 26 | 7 |
| 3 | Bhiwandi | Vehale | Stone mine | 40 | 1.9 |
| 4 | Bhiwandi | Aamne | Stone mine | 90 | 3 |
| 5 | Thane | Kutal | Stone mine | 19 | 7 |
| 6 | Thane | Turbhe | Stone mine | 376 | 2.6 |
| 7 | Thane | Turbhe | Stone mine | 387 | 12.15 |
| 8 | Kalyan | Kachore | Stone mine | 30 | 1.3 |
| 9 | Vasai | Bhatpada | Stone mine | 26 | 2 |
| 10 | Vasai | Doleve | Stone mine | 132 | 2 |
| 11 | Vasai | Poman | Stone mine | 218 | 10.49 |
| 12 | Vasai | Valeev | Stone mine | 33 | 6.49 |
| 13 | Vasai | Kherpada | Stone mine | 26 | 1.9 |
| 14 | Vasai | Mandve | Stone mine | 55 | 3.1 |
| 15 | Borivali | Borivali | Murum | 76 | 16.5 |
| 16 | Thane | Turbhe | Murum | 387 | 12 |
| 17 | Thane | Turbhe / Bhonsari | Murum | 203 | 506 |
| 18 | Thane | Pawne | Murum | 163 | 135 |
| 19 | Thane | Pawne | Murum | 378 | 22 |
| 20 | Thane | Shirawne | Murum | 323 | 64 |
| 21 | Thane | Kukshet | Murum | 183 | 117 |
| 22 | Vasai | Dhaneve | Murum | 51 | 4 |
| 23 | Vasai | Virar | Murum | 375 | 4 |
| 24 | Vasai | Sirangaon | Murum | 352 | 1.9 |
| 25 | Vasai | Bilalpada | Murum | 132 | 5 |
| 26 | Vasai | Shirgaon | Murum | 351 | 3 |
| 27 | Vasai | Nagale | Murum | 62 | 2 |
| 28 | Vasai | Dhaneve | Murum | 51 | 1 |
| 29 | Vasai | Chandansar | Murum | 86 | 2.17 |
| 30 | Vasai | Depivali | Murum | 83 | 1.95 |
| 31 | Vasai | Valeem | Murum | 26 | 6 |
| 32 | Bhiwandi | Dhapode | Murum | 115 | 2 |
| 33 | Bhiwandi | Lonad | Murum | 101 | 2 |
| 34 | Bhiwandi | Talivali | Murum | 110 | 2 |
| 35 | Bhiwandi | Vashere | Murum | 60 | 4 |
| 36 | Bhiwandi | Taveli | Murum | 110/101 | 11.6 |
| 37 | Bhiwandi | Taveli | Murum | 99 | 10 |
| 38 | Bhiwandi | Pise | Murum | 90 | 6 |
| 39 | Bhiwandi | Paye | Murum | 133 | 2 |
| 40 | Bhiwandi | Vashere | Murum | 27 | 24 |
| 41 | Bhiwandi | Samvad | Murum | 86 | 2 |

| | | | | | |
|----|----------|--------------------|-------|-----|----------------|
| 42 | Bhiwandi | Vashere | Murum | 60 | 2 |
| 43 | Bhiwandi | Amne | Murum | 105 | 2 |
| 44 | Bhiwandi | Amne | Murum | 102 | 2 |
| 45 | Bhiwandi | Amne | Murum | 90 | 2 |
| 46 | Bhiwandi | Amne | Murum | 91 | 2 |
| 47 | Bhiwandi | Lonad | Murum | 139 | 2 |
| 48 | Bhiwandi | Lakhiwadi | Murum | 82 | 3 |
| 49 | Bhiwandi | Lakhiwadi | Murum | 88 | 3 |
| 50 | Bhiwandi | Lakhiwadi | Murum | 87 | 3 |
| 51 | Bhiwandi | Talavli | Murum | 105 | 3 |
| 52 | Kalyan | Kaba | Murum | 59 | 2.21 |
| 53 | Kalyan | Kaba | Murum | 85 | 2 |
| 54 | Kalyan | Kaba | Murum | 57 | 4 |
| 55 | Kalyan | Dambool Mooheli | Murum | 34 | 2 |
| 56 | Kalyan | Kaba | Murum | 95 | 1 |
| 57 | Mokada | Kachole | Murum | 162 | 32 |
| 58 | Palghad | Virathambu | Murum | 102 | 1 |
| 59 | Palghad | Mande | Murum | 335 | 8 |
| | | | | | 1115.26 |

CHAPTER-7

PUBLIC CONSULTATION

7.1 INTRODUCTION

“Public Consultation” refers to the process by which the concerns of local affected persons and others who have plausible stake in the environmental impacts of the project or activity are ascertained with a view to taking into account all the material concerns in the project or activity design as appropriate. Consultation is used as a tool to inform stakeholders about the proposed action both before and after the development decisions are made. It assists in identification of the problems associated with the project. Initial Public consultation has been carried out in the project areas with the objectives of minimizing probable adverse impacts of the project and to achieve speedy implementation of the project through bringing in awareness among the community about the benefits of the project.

7.2 METHODS & APPROACH FOR CONSULTATION

Stakeholder consultation was accomplished to collect the opinion/views for the construction of the project. It was held at the doorstep of the people or at a common place of people's gathering. In one to one meeting, people expressed open view and asked openly to understand the project while in gathering combined opinion of the people was collected. Open discussion was held by conducting one to one meeting at project level and district level by disseminating the information either by circulating the project summary or discussing the issue on the desk. At pre-scheduled date and venue, people were communicated to gather for stakeholder consultation. Gathering was explained about the project activities and their consequences in brief. Copy of project summary was also distributed among the stakeholders. Queries of the stakeholder were replied by the environmental expert and at the same time their suggestions were also endorsed.

7.3 CONSULTATION AT PROJECT LEVEL

The consultations were conducted during the reconnaissance/ field visit during second and third week of January 2012 and based on informal unstructured interviews and focus group discussion. The objective of the consultation was to disseminate the project information and ascertain stakeholder's views on probable environmental and social impacts that may arise due to the implementation of the proposed project. Public were intimated about the consultation venue, date and time. The venues, date and time of the public consultations are presented in **Table 7.1**. RITES experts with MMRDA officials explained about need of the project describing social and environmental issues like land acquisition and use of techniques during construction and time frame of construction period during public consultation. About 93 people from different community participated for public consultation at project level. Of the total participants, 5 persons at Girgaon, 9 at Dharavi and 12 persons at Santacruz had raised the questions related to environmental issues.

TABLE 7.1
PUBLIC CONSULTATION VENUE

| S.No. | Venue of the Public Consultation | No. Of Participant | Time and Venue |
|-------|----------------------------------|--------------------|-------------------------------------|
| 1 | Girgaon | 14 | 14:30 PM, 13 th Jan 2012 |
| 2 | Dharavi | 34 | 13:30 PM, 16 th Jan 2012 |
| 3 | Dori Nagar, Santacruz | 45 | 14:00 PM, 17 th Jan 2012 |
| 4 | Dori Nagar, Santacruz | | 16:00 PM, 17 th Jan 2012 |

During consultation, people were explained about the project describing activities involved during construction and operation of the project. The following issues were discussed during the consultations.

- Overall need of the project;
- Project location;
- Environmental concerns; and
- Social concerns.

Issues raised by the stakeholders were replied and their valuable suggestions were noted down for consideration into the report which is depicted at **Appendix 7.1**. Some of the important views expressed and suggestions given by the participants are as follows:

The photographs showing stakeholders participation at public consultation held at various places are shown in **Figure 7.1**.

FIGURE 7.1
PHOTOGRAPHS OF PUBLIC CONSULTATION AT PROJECT LEVEL



7.4 ISSUES, SUGGESTIONS AND MITIGATION MEASURES

Table 7.2 depicts the stakeholders' consultation at project level in which issues raised by stakeholders and their suggestions have been incorporated. The suggestive mitigation measures are taken in detail in the last column of the table.

TABLE 7.2
PROJECT LEVEL STAKEHOLDERS' CONSULTATION

| ISSUES RAISED | SUGGESTIONS OF STAKEHOLDERS | MITIGATION MEASURES |
|-----------------------|---|--|
| Muck Transportation | Compact engineering solution through traffic management, monitoring of air, noise and vibration and safety precautions. | Traffic regulatory measures would be developed during construction. Contractor in consultation with local government will prepare traffic management plan for the construction period. Water, air, noise monitoring will be conducted as per schedule. Vibration Monitoring during construction & Operation. |
| Air & Noise pollution | Pollution due to air and noise during the construction and insisted for regular air monitoring. | Latest technology will be adopted to minimize pollution during construction. Air & noise monitoring will be conducted regularly as per schedule. |
| Tree removal | Transplantation and some new trees should be afforested. | Cutting of trees will be minimized wherever possible. Compensatory afforestation will be done by transplanting & planting trees. |
| Work Schedule | Work should be carried out in systematic manner and working hours should be up to 6 pm. | Work will be carried out in systematic manner and the working hours would be up to 6 pm. |
| Employment | Job preference should be given to the local people. | As per policy contractors will give preference to affected PAFs. |
| Muck Disposal | Muck should be disposed at safer site. | Muck will be disposed at identified site & systematic manner. It will be reclaimed immediately after the project completion |
| Construction Depot | It should be kept away from the habitation zone. | Depot has been planned at Aarey Milk colony area which is well away from the habitation. All necessary pollution measures will be adopted at depot. |
| Labour Camp | Provide adequate sanitation facilities and safe drinking water at labour camps | Adequate sanitation facilities and safe drinking water will be provided at labour camps. |

7.5 CONSULTATION AT CITY LEVEL

Consultation meeting was organized with officers of concerned government department and non-government organizations (NGO) of district wide newspaper Notification dated 5th April 2012. The public hearing notification is enclosed at **Appendix 7.2**. A public hearing for concerned stakeholders of the project were organized on 11th April 2012 the details given in **Table 7.3**.

**TABLE 7.3
PUBLIC HEARING NOTICE**

| Date | Time | Venue |
|------------------------------|--------------------|--|
| 11 th April, 2012 | 10.00 am - 1.00 pm | Insurance Institute of India (college of Insurance), 'G'block, Plot no.C-46, Bandra-Kurla Complex, Bandra(E) Mumbai-400051 |

Suggestions / objections from concerned stakeholders were invited for Environmental Impact Assessment and Social Impact Assessment. Public hearing was attended by 200 stakeholders and about 27 stakeholders raised their objection with suggestions. Details of some objection/ suggestions raised by stakeholders relevant to environment are summarized in **Table 7.4**. The photographs of the City level public consultation are given in **Figure 7.2**.

**TABLE 7.4
CITY LEVEL STAKEHOLDERS' CONSULTATION**

| ISSUES RAISED | SUGGESTION/OBJECTION OF STAKEHOLDERS | MMRC REMARK |
|----------------------|---|--|
| Metro Rail Alignment | Metro line 3 to be combined with Metro line 2 and One depot location can be saved. A letter addressed to the then C.S., GoM, Shri Johnny Joseph by Mr/ Shridaran, MD, DMRC was also discussed regarding Charkop-Bandra-Colaba corridor and MMRDA later changed as Charkop-Bandra-Mankhurd corridor. | PPP contract has been awarded for Metro Line 2 (Charkop – Bandra – Mankhurd). Merging with Line 3 is not possible at this stage. Area required for a combined depot will be much greater than the space available at any one site. Combined depot will not be feasible for Metro Train operation of Line-2 and Line-3. |

| | | |
|------------------------------------|--|---|
| Muck Disposal | <p>Aarey Milk Colony should be taken up very strongly. MMRC has a responsibility for mass public transport; it has also responsibility towards environment. How to dispose of the muck coming out of excavation? Where will it be dumped?</p> <p>Mumbai affected by seismic fault line and how you will evacuate passengers?</p> | <p>MMRC is working on several options for muck disposal. Due care will be taken with regards to environmental impact.</p> <p>Designs will account for Mumbai's seismic zone. Disaster and evacuation plans will be as per Indian standards.</p> |
| Safety Measures | <p>Expressed doubt regarding completion year 2019 in light of VAG corridor Line 1 experience.</p> <p>How much will be the fare? What are the minimum and the maximum? The area from where the line 3 will go through is a very highly congested area. We have to take great caution because of the underground cables, pipelines, etc.</p> | <p>Based on experience of Line 1 and other underground metros in India MMRC will device a construction plan including comprehensive utility diversion to complete project within given time frame. MMRC is in the process for fare fixation for line 3.</p> |
| Underground Utilities & DMP | <p>MMRC to take utmost care for underground utilities</p> <p>Disaster Plan and Evacuation Plan etc. to be prepared.</p> | <p>MMRC will device a comprehensive utility diversion plan. Disaster and evacuation plans will be as per Indian standards</p> |
| Duplication of Metro Line 2 & 3 | <p>Difficult to understand the logic of having 2 parallel lines. (Metro Line 2 & 3).</p> | <p>Line 2 and 3 are serving different areas and there is no duplication.</p> |
| Cost/Km | <p>Enquired about cost per k.m. of underground metro.</p> | <p>Approximate cost of u/g metro is Rs 600 cr / km</p> |
| Connectivity | <p>Enquired about people living in Ballard Estate, Colaba, Gateway of India to access metro station.</p> <p>How will you connect this metro line with the main line?</p> | <p>CST station, Churchgate, Cuffe Parade Station and Hutatma Chowk stations serve these areas. Metro stations will be integrated with suburban stations at interchange points with main lines.</p> |
| DMP, evacuation plan, seismic zone | <ol style="list-style-type: none"> 1. High cost of underground metro 2. Suburban train overcrowded , 44% walk trips and 3.1% cars 3. Enquired about technical details of metro line 3 | <p>Technical details and DPR is available for review at MMRC office.</p> <p>Tunnelling by TBM, stations by either cut and cover or</p> |

| | | |
|------------------|--|--|
| | <p>4. DPR not available</p> <p>5. Method of construction</p> <p>6. Disaster Management Plan, Evacuation Plan etc.</p> <p>7. Mumbai affected by seismic zone</p> <p>8. Commuter dispersal at stations</p> <p>9. Encouraged BRTS due to less cost and less time for construction.</p> <p>10. Metro projects are very costly & time consuming</p> | <p>NATM.</p> <p>MMRC will device a comprehensive utility diversion plan. Disaster and evacuation plans will be as per Indian standards</p> <p>MMRC will take due care during detailed design stage</p> <p>Since ridership is in excess of BRTS capacity metro is required to satisfy demand.</p> |
| Fire Safety | <p>Indian Institute of Shipping are involved in fire safety and can guide MMRC, if associated.</p> <p>How to minimise construction cost?</p> | <p>MMRC will consider the proposal.</p> |
| Station Location | <p>There are 2 stations. It is going through Marol slum. Why these stations are so close? Why it should go through the slum?</p> | <p>Marol naka station is an interchange station with Line 1. 3 stations have been proposed in Airport as per their requirement.</p> |
| Metro Corridor | <p>Whether Metro alignment is underground or elevated.</p> | <p>Proposed Metro line-3 is fully U/G</p> |

FIGURE 7.2
PHOTOGRAPHS OF STAKEHOLDERS' CONSULTATION AT CITY LEVEL





Appendix 7.1

Project Level Public Consultation




PUBLIC CONSULTATION

NAME OF THE PROJECT : EIA STUDY FOR MUMBAI METRO FROM COLABA TO SEEPZ


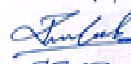


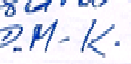





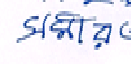


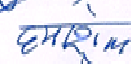
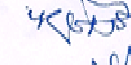
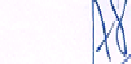
| LOCATION | DATE | STAKEHOLDERS | ISSUES DISCUSSED | SUGGESTION BY STAKEHOLDERS | SIGNATURE |
|---|-----------|---|--|---|---|
| ① Girgaon Girgaon Elata Co-op Hsg Ltd | 13/1/2012 | Pramod Pawar (Hon. Chairman) | During construction, noise generation would be hampered 1. Traffic congestion 2. Increase in pollution 3. Vibration during work & operation 4. Risky work being underground work | Compact engineering solution 2. Traffic management during construction 2. Monitoring for air, noise and vibration etc 3. Safety precautions etc. |  13/01/12 9819673720 7303701085 |
| ② Girgaon Girgaon Co-op Hsg Ltd | 13/1/2012 | Hemant Sagarwalekar (Hon. Secretary) | 1. Tree cutting 2. Mangrove should not be disturbed 3. Mumbai is formed after joining seven islands | Tree should be banded/planted and some new trees should be afforested. Precaution during tunneling should be considered. |  13/01/2011 989475757 |

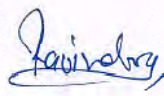

PUBLIC CONSULTATION

NAME OF THE PROJECT : EIA STUDY FOR MUMBAI METRO FROM COLABA TO SEEPZ

| LOCATION | DATE | STAKEHOLDERS | ISSUES DISCUSSED | SUGGESTION BY STAKEHOLDERS | SIGNATURE |
|-----------|-----------|---------------------------------------|--|---|---|
| ③ Girgaon | 13/1/2012 | Gaurav Sagarwalekar (Jr Secretary) | Work in daylight The B.M.H. & zone, Dust problem | Water spraying Air monitoring |  13/01/12 9819673720 |
| ④ Girgaon | 13/1/2012 | Shantilal Gade | Progress of work should be in systematic manner | No haphazard work proper safety measures |  13/01/2012 9967657959 |
| ⑤ Girgaon | 13/1/2012 | Asit Khot | Employment to local people job duty rotation of metro No cultural conflict. | First preference should be given to local |  13/1/2012 9870077427 |

PUBLIC CONSULTATION (पुब्लिक सुनवाई) at SANTACRUZ was held to discuss environmental and social issues on 17.01.2012 (Tuesday) following were present. Issues discussed and suggestion suggested by stakeholders are given at format attached

| <u>Sl. No.</u> | <u>Name/Plan</u> | <u>Signature</u> |
|----------------|--|---|
| 1. | Basant Shinde (9969540836) 26689153 |  17/01/12 |
| 2. | Devindra Lad |  |
| 3. | Fatima D'souza |  |
| 4. | B. N. Pawar |  |
| 5. | Suresh Chandra Pawar |  |
| 6. | D. M. Kulkarni |  |
| 7. | Vijay D. Pawar |  |
| 8. | Sudhir Kumar |  |
| 9. | Gurpreet Singh |  |
| 10. | Shamshad Ahmad |  |
| 11. | Shirish |  |
| 12. | Shirish |  |
| 13. | K. S. Shinde |  |
| 14. | S. S. Shinde |  |
| 15. | K. S. Shinde |  |
| 16. | MAHANGILAL KAMOTI |  |

| Sr no | Name/ Phone no | Signature |
|-------|-------------------------|---|
| 17. | MARANEHI DEVI |  |
| 18. | मनोज म. चांदोरकर | म. चांदोरकर |
| 19. | तुकाराम दा. सकर | त. दा. सकर |
| 20. | बाळाजी सरनोबत | बा. सरनोबत |
| 21. | अनिल कुमार स-नौजिया | अनिल |
| 22. | अनवर अलि रवान | अनवर |
| 23. | Prajwal Chakrawala | Prajwal Chakrawala |
| 24. | सौ. सज्जदा सुहेल नारवकर | सौ. सु. सु. ना. |
| 25. | रेखा रवि मोकर | रेखा मोकर |
| 26. | अपर्णा अरोक राणे | अपर्णा |
| 27. | अ. भरत मो. खांडेकर |  |
| 28. | जिलेन्द्र मोरे | जिलेन्द्र |
| 29. | शकुंतला का. घासीठ | शकुंतला |

PUBLIC CONSULTATION

NAME OF THE PROJECT : EIA STUDY FOR MUMBAI METRO FROM COLABA TO SEEPZ

| LOCATION | DATE | STAKEHOLDERS | ISSUES DISCUSSED | SUGGESTION BY STAKEHOLDERS | SIGNATURE |
|----------|----------|-----------------------------------|---|--|-----------|
| Sankar | 17.01.12 | Basant Dude Anil Chouhan | Sankar Station at stilled ground. 2. Sinking done by inhabitants. without compaction | Waterlogged area may have own problem during construction of tunnel and station. Precautionary measures: Soil investigation, Groundwater study. Sound proof design Safety measures during construction & operation. No littering allowed. Adequate sanitation facilities & safe drinking water | |
| | | | Muck/Debris Labour Camp | | |

PUBLIC CONSULTATION

NAME OF THE PROJECT : EIA STUDY FOR MUMBAI METRO FROM COLABA TO SEEPZ

| LOCATION | DATE | STAKEHOLDERS | ISSUES DISCUSSED | SUGGESTION BY STAKEHOLDERS | SIGNATURE |
|---------------------------------|----------|-------------------|--|---|--------------------------------------|
| Dorn Naga Sankar Gang. | 17.01.12 | List enclosed. | Air noise Excavation Soil - | Should be monitored as per parameter It should be within limit during construction. Muddy land before 1966 like circle. 15 ft filling. Filled by | Signature in enclosed sheet |
| | | | Muck. Green Belt Development | only debris, not a compact filling. Debris also used. It should be dumped at identified location or where it is required. Densification of rail corridor. | |

Safety measure During Construction
& operating safety
should be maintained.

PUBLIC CONSULTATION

NAME OF THE PROJECT : EIA STUDY FOR MUMBAI METRO FROM COLABA TO SEEPZ

| LOCATION | DATE | STAKEHOLDERS | ISSUES DISCUSSED | SUGGESTION BY STAKEHOLDERS | SIGNATURE |
|----------|----------|---------------|--|---|-----------|
| Sanveem | 17.01.12 | List enclosed | Training to workers and staff Shaking of ground | As per requirement training prior to deployment needs. Shaking of ground during tunneling should be controlled to have minimal impact to nearby structures & facilities during construction & operation. Monitoring needs. to be maintained as per standard. Disposed at industrial MCCM dug site. treated / MCCM water supply. | |
| | | | Ar & Noise SWM Drinking water | | |

PUBLIC CONSULTATION

NAME OF THE PROJECT : EIA STUDY FOR MUMBAI METRO FROM COLABA TO SEEPZ

| LOCATION | DATE | STAKEHOLDERS | ISSUES DISCUSSED | SUGGESTION BY STAKEHOLDERS | SIGNATURE |
|-----------------------------|----------|---|------------------|---|-----------------------------|
| Dorji Nagar Sanku Con 2. | 17.01.12 | List of stakeholders attended enclosed. | | Local employment All the given opportunity in metro. | Signature in enclosed sheet |
| | | | | | |

PUBLIC CONSULTATION AT SANTA CRUZ (DORI) NAGAR
on 17.01.2012 (TUESDAY)

| S.No. | Name | Signature |
|-------|-------------------------|-------------|
| 1. — | ABDUL RAUF SHAIKH | Rauf |
| 2. — | MITHA LAL | Mithalal |
| 3. — | शिवधर शिंदे 21/2/12 | Shivkar |
| 4. — | Shujauddin. S. Shaikh. | Shujauddin |
| 5. — | Asif. Qureshi | Asif |
| 6. — | Mrs. SAIRA SAIYED, | Saira |
| 7. — | Harun Ahmad Khan | Harun |
| 8. — | M. KAMIL QURESHI | M. KAMIL |
| 9. — | SHAKIL MANSOOR SIDDIQI. | Shakil |
| 10. — | M.D. AP TAB Khan | M.D. AP TAB |
| 11. — | शिवधर शिंदे 21/2/12 | Shivkar |
| 12. — | S. Abubakar. | S. Abubakar |

PUBLIC CONSULTATION

NAME OF THE PROJECT : EIA STUDY FOR MUMBAI METRO FROM COLABA TO SEEPZ

M. P. MANDRA, DUMBOUR CITY,
Dr. Sonjay Pradhan AM/VP/ITES.

| LOCATION | DATE | STAKE HOLDERS | ISSUES DISCUSSED | SUGGESTION BY STAKEHOLDERS | SIGNATURE |
|----------|------------|---|---|---|--|
| Dharavi | 16/11/2012 | M. Shateel Q. Khan | Crossing through mangrove areas | 1. Traffic management 2. avoid water drinking Should be protected being the tunnel below its root. | <i>[Signature]</i> S. Khan |
| Dharavi | 16/11/12 | A. B. J. A. J. K. R. M. D. G. S. S. S. S. S. A. J. S. S. S. S. | Tunnel below some below ground level Air and Noise Tree | During construction effecting tunneling should be seen. It should be monitored during construction and operation. Although the tunnel not be affected, there effecting, re-plantation should be done. | <i>[Signature]</i> <i>[Signature]</i> <i>[Signature]</i> |

M. S. Sankar, RITES
Dr. S. Sankar, RITES

PUBLIC CONSULTATION

NAME OF THE PROJECT : EIA STUDY FOR MUMBAI METRO FROM COLABA TO SEEPZ

| LOCATION | DATE | STAKEHOLDERS | ISSUES DISCUSSED | SUGGESTION BY STAKEHOLDERS | SIGNATURE |
|----------|----------|--------------------------|------------------|---|--------------------|
| Shamir | 16/12/12 | 21/12/12 conflict EIA | Foundation | to 8 ft below ground level. It should be taken care of thereby and other places. | 22/12/12 Kamish |
| | | Alkathia fencings | | MCGM & MHEDA should provide foundation details along the metro alignment to contractor. | Alkathia |
| | | | | | |
| | | | | | |

Notice for City Level Public Hearing

5th April 2012
TOI

S BY BIDS THE TIMES



Mumbai Metro Rail Corporation Limited
MMRDA Building, Bandra Kurla Complex, Bandra (East), Mumbai- 400 051
Phone: +91-022-2659 4000, Fax: +91-022-2659 4182,
e-mail: mmrcltd2010@gmail.com; web: <http://www.mmrdamumbai.org>

NOTICE FOR PUBLIC HEARING

IMPLEMENTATION OF MUMBAI METRO LINE-3 (COLABA-BANDRA-SEEPZ)

Ref: Mumbai Metro Rail Corporation public notification dt. 12th Dec 2011 in Hindustan Times, Navbharat and Lokmat

- Government of Maharashtra has decided to implement Mumbai Metro Line 3; Colaba - Bandra - SEEPZ (fully underground) project through Mumbai Metro Rail Corporation (MMRC). Vide above referred notification, suggestions / objections for Social and Environmental Impact of the project were invited.
- In this regard a public hearing for concerned stakeholders of the project is proposed to be organised as per details given below.

| Date | Time | Venue |
|------------------------------|--------------------|--|
| 11 th April, 2012 | 10.00 am - 1.00 pm | Insurance Institute of India (college of Insurance) 'G' Block, Plot No. C-46, Bandra-Kurla Complex, Bandra (E), Mumbai- 400051 |

- Interested Stakeholders are invited to attend the public hearing and submit their written and /or oral suggestions / objections.

For further details contact Shri R. Ramana, Additional Chief (Transport Planning), Transportation and Communications Division at above mentioned address.

Place : Mumbai

Date: 5th April 2012

Sd/-
(S. V. R. Srinivas, IAS)
Managing Director
Mumbai Metro Rail Corporation

Shalini P. Chaudhary, Mumbai

CHAPTER - 8

ENVIRONMENTAL MONITORING PLAN

The environmental monitoring programme is a vital process of any Environmental Management Plan (EMP) of development project for review of indicators and take immediate preventive action. This helps in signalling the potential problems resulting from the proposed project activities and will allow for prompt implementation of corrective measures. The environmental monitoring will be required during both construction and operational phases. The following parameters are proposed to be monitored:

- Water Quality,
- Air Quality, Noise and Vibration,
- Soil monitoring,
- Ecological Monitoring,
- Workers Health and Safety

Environmental monitoring during pre-construction phase is important to know the baseline data and to predict the adverse impacts during construction and operations phases. Pre-construction phase monitoring has been done for the proposed project for air, noise, vibration, water, soil quality and ecology. The results so obtained are documented in **Chapter 3**.

8.1 ENVIRONMENTAL MONITORING PLAN

8.1.1 Water Quality Monitoring

Though it is expected that, no impact on water quality is anticipated, monitoring of water quality may be required to assess the impact of the project before and after construction. Water quality parameters shall be monitored one year before the construction, during the construction phase and also for at least three years after the completion of the project (Total 9 years). Monitoring shall be carried out at least three times a year to cover seasonal variations. The parameters for monitoring and sampling frequency during construction and operation period are given in the **Table 8.1**. The main monitoring stations could be about four locations. The cost for water quality analysis works out to be **Rs. 10.80 lakhs**.

TABLE 8.1
WATER QUALITY MONITORING PROGRAMME

| ITEMS | DESCRIPTION |
|------------------------------|---|
| Parameters to be monitored | pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids, Chlorides, Nitrates, Sulphates, Total Nitrogen, Lead, Total Phosphates, oils and grease. |
| Location during construction | 4 locations as per decision of Engineer in Charge |
| Location during operation | Depot, Caffe Parade station, Dharavi station and MIDC station. |
| Frequency | Once in a season for three season in a year for nine years. |
| Monitoring Cost (Rs.) | Rs. 10.80 Lakhs. |

Monitoring should be carried out by NABL certified private or Government agency. Water quality should be analyzed following the procedures given in the standard methods. Parameters for monitoring will be as per BIS: 10500. The monitoring points could be at source of ground and surface water.

8.1.2 Soil Monitoring

Soil quality will be tested for the soil sample taken from site of Depot, Labour camp, station location, dumping site and at random sampling of soil from the muck coming out during tunneling. The soil quality monitoring programmes are given in **Table 8.2** and **Table 8.3**.

TABLE 8.2
SOIL QUALITY MONITORING PROGRAMME

| ITEMS | DESCRIPTION |
|--------------------------------|---|
| Parameters to be monitored | pH, Sodium, Potassium, Chloride, Nitrogen, Phosphorous, Organic Matter, Heavy Metals, Oil and Grease. |
| Location during construction | Depot, Labour Camp, Dumping site and Stations (as per decision of Engineer in Charge) |
| Proposed Site during operation | Depot |
| Frequency | Three samples in a season and three times in a year for nine years. |
| Monitoring Cost (Rs.) | Rs. 29.16 Lakhs |

TABLE 8.3
SOIL QUALITY MONITORING PROGRAMME FOR MUCK

| ITEMS | DESCRIPTION |
|----------------------------|--|
| Parameters to be monitored | pH, Electrical conductivity, Alkalinity, Moisture content, texture, Heavy Metals and Specific gravity. |
| Location | Every Kilometer |
| Frequency | At random sampling @ three sample in one km. |
| Monitoring Cost (Rs.) | Rs. 6.30 Lakhs |

8.1.3 Air Quality, Noise and Vibration monitoring

Ambient air quality and Noise levels should be monitored one year before the construction, during the construction phase and for at least three years after the completion of the project. It is proposed to have the monitoring programme at four locations. The cost for ambient air quality, Noise levels and Vibration Monitoring works out to be **Rs. 152.82 lakhs** as per the break up given in **Table 8.4**, **Table 8.5** and **Table 8.6** respectively.

TABLE 8.4
AIR QUALITY MONITORING PROGRAMME

| ITEMS | DESCRIPTION |
|--------------------------------|---|
| Parameters to be monitored | PM _{2.5} , PM ₁₀ , SO ₂ , NO _x , CO, HC |
| Location during construction | 6 locations including depot and sensitive locations as per decision of Engineer in Charge |
| Proposed Site during operation | Depot, Vidhan Bhawan station, CST Station, Dharavi station, CSIA (Domestic Airport) and MIDC station. |
| Frequency | Twice in a week for each season for three season in a year for nine years. |
| Monitoring Cost (Rs.) | Rs. 48.60 Lakhs. |

TABLE 8.5
NOISE QUALITY MONITORING PROGRAMME

| ITEMS | DESCRIPTION |
|--|--|
| Parameters to be monitored | Leq, L90, L50, L10, Lday, Lnight, Lday-night |
| Location during construction | 6 locations including depot and sensitive locations as per decision of Engineer in Charge |
| Proposed Site during operation | Near Vidhan Bhawan station, Siddhi Vinayak Temple, Dharavi station, CSIA (Domestic Airport) and MIDC station and at Depot. |
| Sampling duration for during & after construction period | Twice in a week for each season for three season in a year for nine years. |
| Monitoring Cost (Rs.) | Rs. 9.72 Lakhs. |

TABLE 8.6
VIBRATION MONITORING PROGRAMME

| ITEMS | DESCRIPTION |
|-----------------------------------|--|
| Parameters to be monitored | For Construction: Field Measured Average Ambient vibration (VdB) & Vibration due to TBM Operation (VdB). For Operation: Vibration due to Metro Train Operation (VdB). |
| Proposed Site during construction | At CST, BMC Building, Lady Willingdon Building, Mittal Towers, DN Road and other locations as required. |
| Proposed Site during operation | At CST, BMC Building, WR Head Quarter, Girgaon station, Lady Willingdon Building, Mittal Towers & DN Road. |
| Frequency | Continuous monitoring during tunnelling at work stations and 4 years during operation. |
| Monitoring Cost (Rs.) | Rs. 94.50 Lakhs. |

8.1.4 Ecological Monitoring

The project authority in coordination with the Department of Forest shall monitor the status of ecology/trees along the project corridors at regular interval during construction phase in order to maintain the ecological environment. The plantation/afforestation of trees by Department of Forest, Government of Maharashtra will be reviewed regularly by MMRDA during construction Phase.

8.1.5 Workers Health and Safety

Monitoring of health risk issues that might arise throughout the project life time will be done. Epidemiological studies at construction sites and workers camp will be performed to monitor the potential spread of diseases. Regular inspection and medical checkups shall be carried out to workers health and safety monitoring. Any recurring incidents such as irritations, rashes, respiratory problems etc shall be recorded and appropriate mitigation measures shall be taken. Contractor will be responsible to take care of health and safety of workers during the entire period of construction and project proponent will review/audit the health and safety measures/plans regularly.

8.2 ENVIRONMENTAL MONITORING DIVISION

It is recommended that MMRDA establishes an Environment Division at the initial stage of the project itself. The division should be staffed with an Environmental Engineer/Officer and a Technical Assistant (environment background). The task of the division would be to supervise and coordinate studies, environmental monitoring and implementation of environmental mitigation measures, and it should report directly to Project Director of the project authority. Organizational setups for Environmental Monitoring during construction and operation phase are presented in section 6.3. Costs for the first ten years (including 10% annual increase has been) given **Table 8.7**.

TABLE 8.7
ENVIRONMENTAL DIVISION COSTS

| S. No | Particulars | In Rupees |
|--|-------------------------------|-------------------|
| Per Year | | |
| 1. | Environmental Engineer (1No.) | 5,40,000 |
| 2. | Technical Assistant (1No.) | 3,00,000 |
| 3. | Miscellaneous Expenditure | 2,00,000 |
| Total Cost per One Year | | 1,040,000 |
| Total Cost for Ten Years with 10% annual increase | | 11,440,000 |

CHAPTER-9 COST ESTIMATES

9.1 SUMMARY OF COSTS

The environmental costs towards implementation of environmental management plan and mitigation measures during pre-construction, construction and operation of the proposed project are estimated of **Rs. 2878.27** lakhs and described in **Table 9.1**. These costs are computed in Chapter 6 and Chapter 8. Certain items in the environmental management plan make part of the contractual obligations of the construction contractor. Breakdown of the cost may be referred as per the section described in Table 9.1.

**TABLE 9.1
ENVIRONMENTAL COSTS**

| S. No. | ITEM | REFERENCE | COST Rs Lakhs |
|---------------|--|------------------|----------------------|
| 1. | Tree Plantation and Transplantation | Section 6.3.1 | 641.95 |
| 2. | Sanitation facilities at Labour camp | Section 6.3.4 | 21.56 |
| 3. | Water supply & Sewage/ Effluent Treatment at Depot | Section 6.3.20 | 110.00 |
| 4. | Green Belt Development & Rain Water Harvesting at Depot | Section 6.3.20 | 55.00 |
| 5. | Environmental monitoring during construction and operation | Section 8.1 | 199.08 |
| 6. | Muck Disposal | Section 6.3.15 | 1435.18 |
| 7. | Training Programmes | Section 6.3.21 | 216.10 |
| 8. | Establishment of Environment Division | Section 8.2 | 114.40 |
| 9. | Environmental Enhancement Measures | Section 6.3.22 | 85.00 |
| | Total | | 2878.27 |

Cost of Rehabilitation and Resettlement has been presented in separate report. The Environmental management plan should be implemented in phases so that optimum benefit could be achieved and should be synchronized with the construction schedules.

CHAPTER-10

CONCLUSION

The proposed Metro line is proved to have significant positive effects to the development of Mumbai City. Benefits to the economy, traffic congestion reduction, quick and safety transport, employment opportunities, fuel consumption reduction, and air quality improvement are the obvious positive effects from this Metro line. Besides, the potential adverse environmental impacts on air quality (during construction phase), water environment, noise and vibration, solid waste, ecology, population resettlement are also taken into consideration. Hence the current project is classified as Category 'A' as per the JICA Guidelines for confirmation of Environmental and Social Considerations. Based on these detailed potential adverse environmental impacts, appropriate mitigation measures have been developed for consideration. The EIA concluded that project impacts from both construction and operation will be minimal, and can be mitigated through the use of prevailing current practices and appropriate technologies. With the implementation of the EMP and the monitoring plan, the Project is not expected to have significant environmental impacts.