Environmental Impact Assessment

March 2021

India: Chennai Metro Balance Corridor 5

Prepared by Chennai Metro Rail Limited (CMRL) for Project Lenders

CURRENCY EQUIVALENTS
(as of 1 January 2021)

Currency unit	–	Indian rupees (₹)
₹1.00	=	$0.0137
$1.00	=	₹73.094

ABBREVIATIONS
To be Added

WEIGHTS AND MEASURES

^{0}C	-	degree Celsius
dB(A)	-	decibel acoustic
ha	-	hectare
km	-	kilometer
km/h	-	kilometer per hour
kWe	-	kilowatt-electric
kV	-	Kilo volt(s)
kVA	-	kilo Volt-Amps
kW	-	kilowatt
m	-	meter
mm	-	millimeter
MVA	-	Megavolt Ampere
MW	-	Megawatt
m^3	-	cubic meter
m^3/hr	-	cubic meters per hour
mg/l	-	milligrams per liter
m/s	-	meters per second
MTPA	-	metric tons per annum
MW	-	megawatt
ppm	-	parts per million
ppt	-	parts per thousand
rpm	-	revolutions per minute
µg/m^3	-	microgram per cubic meter

NOTES

(i) The fiscal year (FY) of the Government of India ends on 31 March. FY before a calendar year denotes the year in which the fiscal year ends, e.g., FY2020 ends on 31 March 2020.

(ii) In this report, "$" refers to US dollars.

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EXECUTIVE SUMMARY

1. Chennai, the capital city of the state of Tamil Nadu, is part of the Chennai Metropolitan Area (CMA) that is home to over 8 million people and plays a vital role in the economy of South India.[1] Like other metropolitan areas in the country, CMA is currently facing the challenges of accelerated urbanization growth that have considerably strained the area's transportation system. The increase in economic activities has boosted the regional economy and job creation, which in turn necessitates improvement in ease of travel and connectivity.

2. Chennai Metro Rail Limited (CMRL), a joint venture of the Government of India (GoI) and the Government of Tamil Nadu (GoTN) with equal equity ownership, is responsible for implementing, operating, and maintaining the city's metro system. CMRL developed the Comprehensive Mobility Plan for CMA in 2015 and identified three corridors (corridors 3, 4, and 5) for the second phase of the Chennai Metro Rail to alleviate CMA's transportation capacity constraints.

3. GoI requested the Multilateral Development Banks [2] (MDBs) to assist the implementation of 29.142 km line connecting Chennai Mofussil Bus Terminal (CMBT) to Okkiyam Thoraipakkam Metro (Ok. Tho) including 28 stations (CMBT and Ok. Tho stations are not included in the 28 stations per the detailed design consultant). This section (Balance C5) forms part of Chennai Metro Rail Corridor 5 sharing 4 stations in common with Corridor 4, allowing interchange with Corridor 3, Corridor 1 and Corridor 2 of Phase I Metro and MRTS and connecting with suburban railway system. Remaining section of the Corridor 5 from Madhavaram to CMBT which is being financed by Japan International Cooperation Agency (JICA) constitutes one of the Associated Facilities to Balance C5.

4. The capital cost of Balance C5 including taxes and duties for December 2018 is estimated at USD 1,037 million, USD 107.51 million as compensation for land and structures, and Resettlement & Rehabilitation (R&R). It is estimated that project will be implemented over a period of 53 months from the date of award of civil works. CMRL will take full responsibility of the implementation of Corridor 5.

5. As per provisions of the EIA Notification 2006 and its subsequent amendments by the Ministry of Environment, Forests and Climate Change (MoEF&CC), Metro Rail Projects are exempted from requirements of Environmental Clearance (EC). However, as the alignment passes through Nanmangalam Reserved Forest between Velakallu and Medavakkam Koot Road, the forest clearance of alienation of forest land to non-forest use will be required. Tree felling permission is required only for Private forest, hill area or sandalwood trees: therefore separate permission not required for the Balance C5.

6. As per MDBs' Environmental and Social Policies[3], this project has been categorised as 'A' due to the significant impacts anticipated. Environmental impact assessment (EIA) was conducted accordingly. The EIA report comprising baseline data on existing conditions of physical, ambient and ecological environment, together with the identified and anticipated environmental impacts and proposed mitigation measures, has been prepared in accordance with GoI's legislative framework and MDBs' policies.

[1] Indian National Census, the Census Organization of India, 2011.

[2] Asian Development Bank (ADB) and Asian Infrastructure Investment Bank (AIIB).

[3] ADB's Safeguard Policy Statement (SPS) 2009, and AIIB's Environmental and Social Framework (ESF).

7. The implementation of the Corridor 5 is expected to generate environmental and socio-economic benefits in terms of decreasing air pollution from replacing the diesel-fueled transportation and from traffic congestion and serving the growing travel demand.

8. As per the proposed alignment and design details, standard Gauge (1435mm) will be adopted with a minimum track center distance of 4000 mm, 16-ton maximum axle load capacity and a design speed of 80 kmph. The elevated station is generally located on the road median at 140 m long and 24 m wide and is a three level structure, with a minimum vertical clearance of 5.50 m under the concourse. To reduce physical and visual impact of the elevated station, stations have been made transparent with minimum walls on the sides. Signaling system shall be adopted for Balance C5 in line with the remaining section of Corridor 5. Rolling stock is of light weight stainless steel/aluminum body for energy efficiency. Universal accessibility has been reflected in the design following international best practices. Green building features like rainwater harvesting, solar energy panels at elevated stations' roofs, will be considered in station design.

9. The terrain along Balance C5 alignment is mostly flat, no more than 3 m above mean sea-level. The soil along the alignment is clayey, sandy and hard rock. Balance C5 alignment is located about 2km from the Guindy National Park, however, the wildlife clearance is not required but project activities will strictly follow the guidelines issued by MoEF&CC regarding the prohibited, regulated and permitted activities and consultations with the Tamil Nadu Forest Department. The alignment is approximately 1km away from Nanmangalam lake which is home to a number of bird species; it also runs along existing road passing through Pallikaranai marshland which is also home to a wide variety of birds and other fauna. Diversion of 7,570 sqm scrub forest land will be required for the stretch traversing the Nanmangalam Reserve Forest. 305 trees are likely to be felled along the corridor up to Ok. Tho.

10. Despite the seemingly abundant sources of water, Chennai suffers continuously from water stress since the entire basin is dependent on rainfall. Water samples has been collected from 7 locations and tested for its quality as per the IS 10500 (drinking water standard).The outcome of the analysis shows most of the key water quality parameters are well within the prescribed permissible limits except for Total Dissolved Solids (TDS) at Global Hospital, turbidity at Alwarthirunagar and Global Hospital, calcium at MIOT Hospital and Medavakkam junction, aluminium at Global Hospital, kaplana Hospital at Adambakkam, Madipakkam Koot Road and Velakallu bus, hardness at MIOT Hospital, Medavakkam junction and Global Hospital and mercury at alwarthirunagar and MIOT Hospital.

11. Ambient air quality (AAQ) monitoring has been conducted for the sensitive receptors along the Balance C5. The outcome of the AAQ results shows that Particulate Matter, Sulphur Dioxide (SO2) and Nitrogen Dioxide (NO2) were within the permissible level of National Ambient Air Quality Standards (NAAQS). Concentration of Carbon Monoxide (CO) exceeded the permissible level of NAAQS in all the monitoring locations but was within WHO guideline.

12. The Ambient Noise Levels monitored at 7 locations along the alignment were above the national and international permissible limits. Noise levels were also monitored at 10 sensitive locations belonging to the silence zone, with 50% slightly exceeding GoI standards of 50dB the daytime limit (none per WHO guideline of 55dB), and none exceeding 40dB the night-time limit. The predominant source of ambient noise at monitored locations is due to road traffic. All the monitoring stations are located on urban arterials and regional highways. A noise study is ongoing and the full baseline will be updated prior to contractor's mobilization.

13. Peak VdB vibration level at 6 out of 8 monitored locations is found to exceed acceptable criteria for ground borne vibration prescribed by the Federal Transit Administration (FTA) USA and Railway Design and Standards Organisation (RDSO) India which are more valid for operation of this project**.** However the observed levels at all 8 locations ranging from 0.049 mm/sec to 2.090 mm/sec are well below the construction vibration damage criteria for blasting as per Indian authorities, the Directorate General of Mines Safety (DGMS) and that Central Institute of Mining and Fuel Research (CMFRI or CMRI) which are relevant only if blasting is undertaken during construction. A full baseline will be collected prior to contractor's mobilization to elaborate the current baseline.

14. Based on the analysis of project and environmental settings, a detailed assessment of potential impacts with respect to project location and design, construction and operation has been carried out. For each of the anticipated adverse impacts, mitigation measures have been proposed as part of the Environmental Management Plan (EMP). The key positive environmental impacts of Balance C5 include reduced use of private vehicle leading to exhausted gas reduction; road congestion status; road safety improvements; increased accessibility and mobility, and a modest reduction in greenhouse gas emissions. The main residual negative impacts of Balance C5 include fugitive and point source dust emission, noise from construction and operation, disposal of large quantities of construction wastes, and occupation and community health and safety, which are mainly temporary and localized, and can be well managed through implementation of EMP and good international industry practice.

15. The main mitigation measures proposed are as follows: (i) to plant twelve saplings for each tree to be cut as against ten saplings ordered for infrastructure projects by the Honorable Madras High Court, with estimated compensatory afforestation cost in place accordingly; (ii) noise reduction measures (i.e. noise barriers at sensitive receptor locations); and (iii) reuse of excavated material where feasible and disposal of construction waste in a regulated manner. Balance C5 will take into consideration the climate change effects of an anticipated continuous increase in ambient temperature, intensity of cyclones and storm surge, heavy precipitation events, and sea level rise in the future. The alignment being elevated inherently contributes to climate adaptation of flooding risks. Climate mitigation to be integrated into Balance C5 design include: (i) using solar panels on station buildings and roofs to reduce the extensive use of grid-generated electricity supplied to the station for its operation and maintenance; and (ii) through better station roof design, providing for rainwater harvesting by channeling rainwater through gutters and pipes to either harvesting pits in the ground or to recharge groundwater.

16. Various alternatives such as modes of transport, alignment, proposed design etc. have been considered and analyzed for its likely impacts on various environmental and social parameters. Additionally, an evaluation of potential environmental and social impacts in terms of 'with' and 'without' project situation has been considered for the justification of Balance C5.

17. Meaningful public consultations were carried out with communities on the alignment during EIA preparation and will continue before start of implementation of Balance C5 and throughout its implementation. Public consultations highlighted opinions of participants on benefits of Metro in terms of reducing congestion on roads. The EIA report and its Tamil executive summary will be disclosed at the CMRL and lenders' websites with hard copies at the project site.

18. Grievance Redress Mechanism (GRM) has been proposed for Balance C5 comprises the procedures to address grievances (i) first at the Project Implementation Unit level, (ii) second at Grievance Redress Committee (GRC), to ensure grievances from Project Affected Peoples (PAPs) and workers are addressed to facilitate timely project

implementation. The GRC will be formed which will have representatives from Contractors, General Consultant (GC), CMRL, local administration, and PAPs. Unsatisfied PAPs will have the option to escalate the grievances at any point of time.

19. An EMP with institutional arrangements, budgetary provisions, schedule for EMP implementation and its monitoring has been prepared, including appropriate mitigation measures, provisions related to occupational health and safety, labour camp and construction site management, traffic and public utility management etc. to address all impacts during Project pre-construction, construction and operation phases. The EMP forms part of the bidding document of the civil works contractors. In addition, stringent monitoring requirements and actions have been included in the Environmental Monitoring Plan (EMoP) on ambient impacts on air, water, and noise and vibration levels. Bi-annually monitoring reports will be prepared by GC and submitted to lenders through CMRL. A third-party monitor will also monitor work independently and submit verification reports to CMRL and lenders. The preliminary estimated cost of the EMP including implementation and monitoring is USD 3.78 million (INR 276 million). This cost estimate is exclusive of land acquisition and R&R cost.

20. Benefits far outweigh negative impacts. Overall, the major environmental impacts associated with Balance C5 are limited to the construction period and can be mitigated to an acceptable level by implementation of recommended measures and by best engineering and environmental practices. The EMP and EMoP shall be revised if necessary, for any unanticipated impacts, during project implementation or if there is any change in the project design and with approval of lenders.

1. INTRODUCTION

1.1 Background

1. Chennai Metropolitan Area (CMA) comprises the city of Chennai, 8 Municipalities, 11 Town Panchayats and 179 Village Panchayats in 10 Panchayat Unions. The extent of CMA is 1189 sq.km. The CMA is covered under three Districts of Tamil Nadu viz. Chennai District (176 sq.km), part of Thiruvallur District (637 sq.km), and part of Kancheepuram District 376 sq.km). In year 2011, resident population of CMA was 8.0 million, while the population projection for year 2026 is 12.6 million.

2. Chennai, the capital city of the state of Tamil Nadu, is part of the Chennai Metropolitan Area (CMA) and plays a vital role in the economy of South India.[1] The Chennai Metropolitan Development Authority (CMDA) devised the Chennai Second Master Plan 2026 and estimated that the population would grow to 12.6 million people with an estimate of daily passenger traffic of 20.8 million in 2026.[2] CMA has emerged as a leading national automotive hub with major manufacturers operating their plants in the area. CMA also houses a growing number of software firms, financial services, and call centers. Like other metropolitan areas in the country, CMA is currently facing the challenges of accelerated urbanization growth that have considerably strained the area's transportation system. The increase in economic activities has boosted the regional economy and job creation, which in turn necessitates improvement in ease of travel and connectivity.

3. The existing transportation system in CMA is marked by high traffic density, carbon emissions, and frequent road incidents. In addition to the high volume of vehicles and already congested roads, inadequate parking space and the encroachment of street space by vendors on major road have exacerbated the traffic congestion. Major roads along the proposed project alignments are forecast to function beyond respective design service volume in year 2035 in absence of the project lines. The accelerating use of private vehicles has put Chennai in the fifth rank in carbon emission from the transport sector among 54 South Asian cities.[3]

4. Inadequate transportation infrastructure and poor service have resulted in an unfavorable decrease in the share of public transport from 54 percent in 1970 to 28 percent in 2014.[4] The Chennai Second Master Plan 2026 proposes to increase the public and private mode split to 70:30. The mass transit transportation, especially an integrated metro system will be essential to achieve this intended split.

5. The city has two mainline railway terminals. Urban Mass Rapid Transit System (MRTS) of 19.35 km from Chennai Beach to Velachery is in operation, land acquisition for balance MRTS section from Velachery to St Thomas Mount is in process. Chennai Metro Phase 1 of 45 kms is in operation, work on extension to Thiruvottiyur is in progress. Chennai suburban railway network supplements MRTS. Schematic diagram of urban mass rapid transit network is in Figure 1.1.

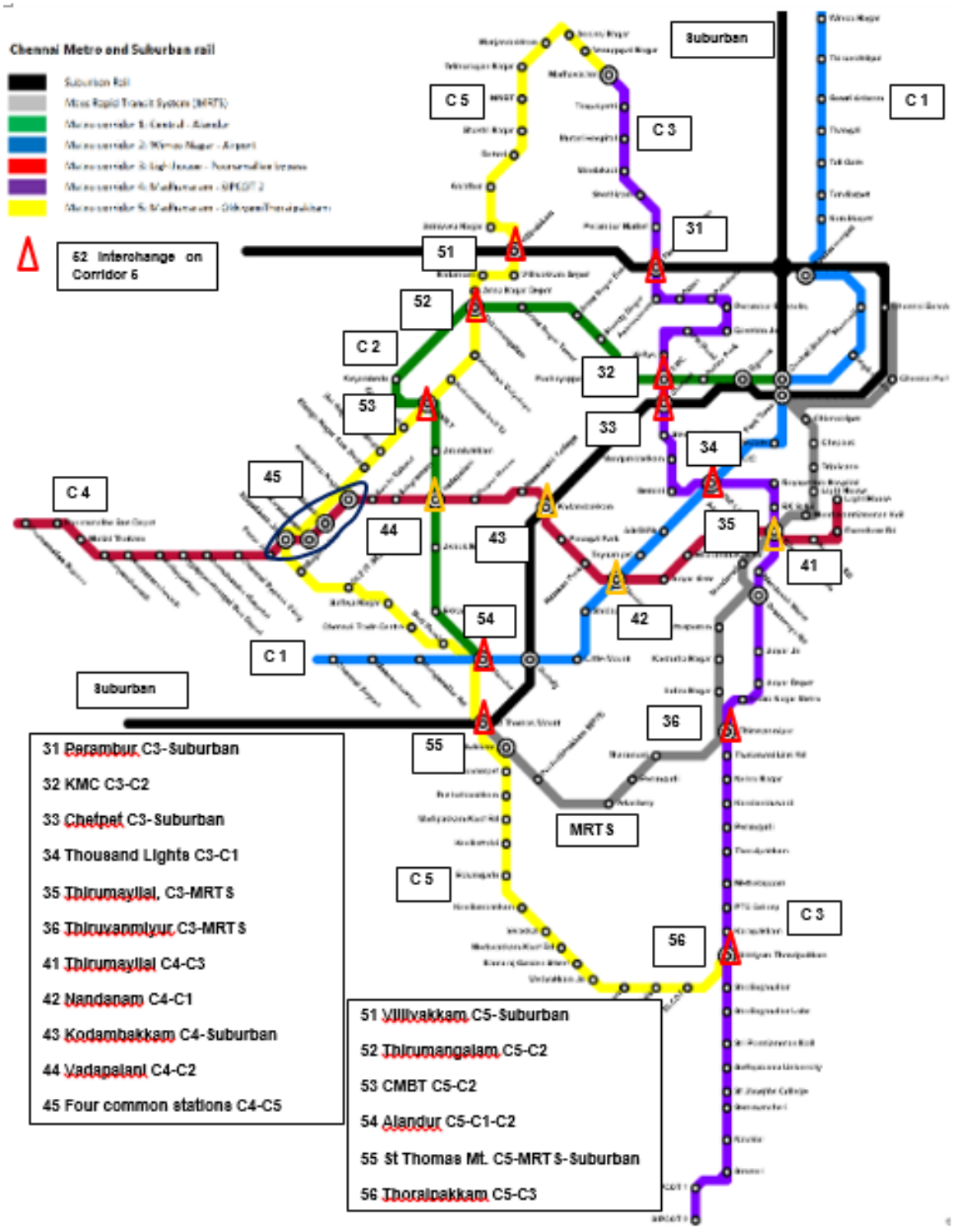
[1] Indian National Census, The Census Organization of India, 2011.

[2] Second Master Plan for Chennai Metropolitan Area 2026, Chennai Metropolitan Development Authority, 2008.

[3] International Council for Local Environmental Initiative Study, 2012.

[4] Comprehensive Detailed Project Report for Chennai Metro Phase-II, Chennai Metro Rail Limited, 2018.

Figure 1.1: Rail Transport Network in Chennai



Source: CMRL

1.1.1 Chennai Metro Rail Network

6. Phase 1 of Chennai metro rail network covers 54.05 km in two corridors. Corridor 1 starts from Washermanpet to Airport (23.09 Km), and extension from Washermanpet to Wimco Nagar (9.00 km) in Thiruvottiyur. Corridor 2 starts from Chennai Central to St.

Thomas Mount (21.96 Km) via Koyambedu. As on February 2020, Phase 1 excluding the extension from Washermanpet to Thiruvottiyur is in commercial operation.

7. The Government of Tamil Nadu (GoTN) has created a Special Purpose Vehicle (SPV) for implementing the Chennai Metro Rail Project. This SPV named as "Chennai Metro Rail Limited (CMRL)" was incorporated on 03.12.2007 under the Companies Act. It has now been converted into a Joint Venture of Government of India (GoI) and GoTN with equal equity holding. CMRL as the implementing agency, shall be responsible for implementing, operating, and maintaining the city's metro system. CMRL developed the Comprehensive Mobility Plan for CMA in 2015 to identify the present and future mobility patterns of CMA. The detailed study identified three corridors (corridors 3, 4, and 5) for Phase 2 of the Chennai Metro Rail to alleviate CMA's transportation capacity constraints.

8. **Corridor 3.** Madhavaram to SIPCOT, length of the corridor is 45.813 km comprising 30 underground stations and 20 elevated stations. It provides interchange with Corridor 4 and Corridor 5. It offers interchange with Phase I Metro and MRTS and connects with suburban railway system.

9. The 35.044 km long section from Madhavaram depot to Sholinganallur station via Adyar runs on the Eastern periphery of the city: it is being funded by JICA. This section comprises 30 underground stations and 10 elevated stations. Viaduct and stations 9.627 km long from Sholinganallur to SIPCOT is being financed by ADB; civil construction is scheduled to be commenced by July 2021 and completed by July 2024. Systems works are scheduled to be completed and metro commissioned by November 2025.

10. **Corridor 4.** Lighthouse to Poonamallee bypass, length of the corridor is 26.8 km comprising underground length 10.3 km and 12 underground stations (Lighthouse to Meenakshi College) and elevated length 16.5 km and 18 elevated stations (Power House to Poonamallee bypass). Corridor 4 has 4 stations in common with Corridor 5, offers interchange with Corridor 3, Phase I Metro and MRTS; it connects with suburban railway system. Construction of the elevated section from Power House to Poonamallee bypass is scheduled to commence in March 2021 and completed by December 2024. Systems works are scheduled to be completed and the entire Corridor 4 is commissioned by December 2026.

11. **Corridor 5.** Madhavaram to Sholinganallur via St Thomas Mount, Revenue length of the corridor is 47.009 km comprising one at grade station, 41 elevated stations and 6 underground stations. It is integrated with Phase I Metro and MRTS; connects with suburban railway system.

12. Balance C5 is the 29.142 km line connecting Chennai Mofussil Bus Terminal (CMBT) to Okkiyam Thoraipakkam (Ok. Tho) including 28 stations. CMBT forms part of Corridor 5 from Madhavaram to CMBT being financed by JICA and Ok. Tho forms part of Corridor 3. The Balance C5 has 4 stations in common with Corridor 4. Construction of viaduct and stations of MDB Corridor 5 from CMBT to Ok. Tho is scheduled to be commenced by July 2021 and completed by June 2024. Systems works are scheduled to be completed and metro commissioned by November 2025. It is financed by AIIB for civil works and ADB for systems.

1.2 Environmental Impact Assessment

1.2.1 Categorization

13. Based on assessment of significance of impacts borne out of field visits and secondary information, Balance C5 was categorized as A. Although, the proposed project will bring in many benefits to the area, the civil works pose significant environment, health

and safety risks as well. Therefore, the project requires full impacts assessment to be documented in an Environmental Impact Assessment (EIA) Report.

1.2.2 Purpose of the EIA Report

14. This EIA report documents the environmental impact assessment of Balance C5 and identifies the environmental issues to be considered at planning and design stage. In this report, the different activities that are likely to take place during construction and operation, have been analysed and the potential impacts that may accompany them have been discussed. The EIA addresses the environmental management requirements of GoI and the lenders. In general, the EIA Report is outlined as below to address various aspects:

- Provide background of the project in terms of land use, existing Metrorail network and the proposed Metrorail corridors, methodology of preparation of the report and its content;
- Analysis of policy and legal framework within which environmental safeguards for the project shall be recommended and implemented;
- Provide information about the baseline environmental settings;
- Provide information on potential environmental impacts of Balance C5 with its magnitude, distribution, and duration;
- Provide information on required mitigation measures with cost to minimize the impacts;
- Analysis of the alternatives considering alternative locations, designs, management approaches, for selection of most feasible and environmental acceptable options;
- Provide details of stakeholders' consultations;
- Plans for stakeholders to communicate grievances and suggestions and for their Redressal; and
- Formulate environmental management and monitoring plan with institutional measures for effective implementation of mitigation measures proposed.

15. Social Impact Assessment (SIA) with a Resettlement Action Plan (RAP) for implementation is presented as a separate Report.

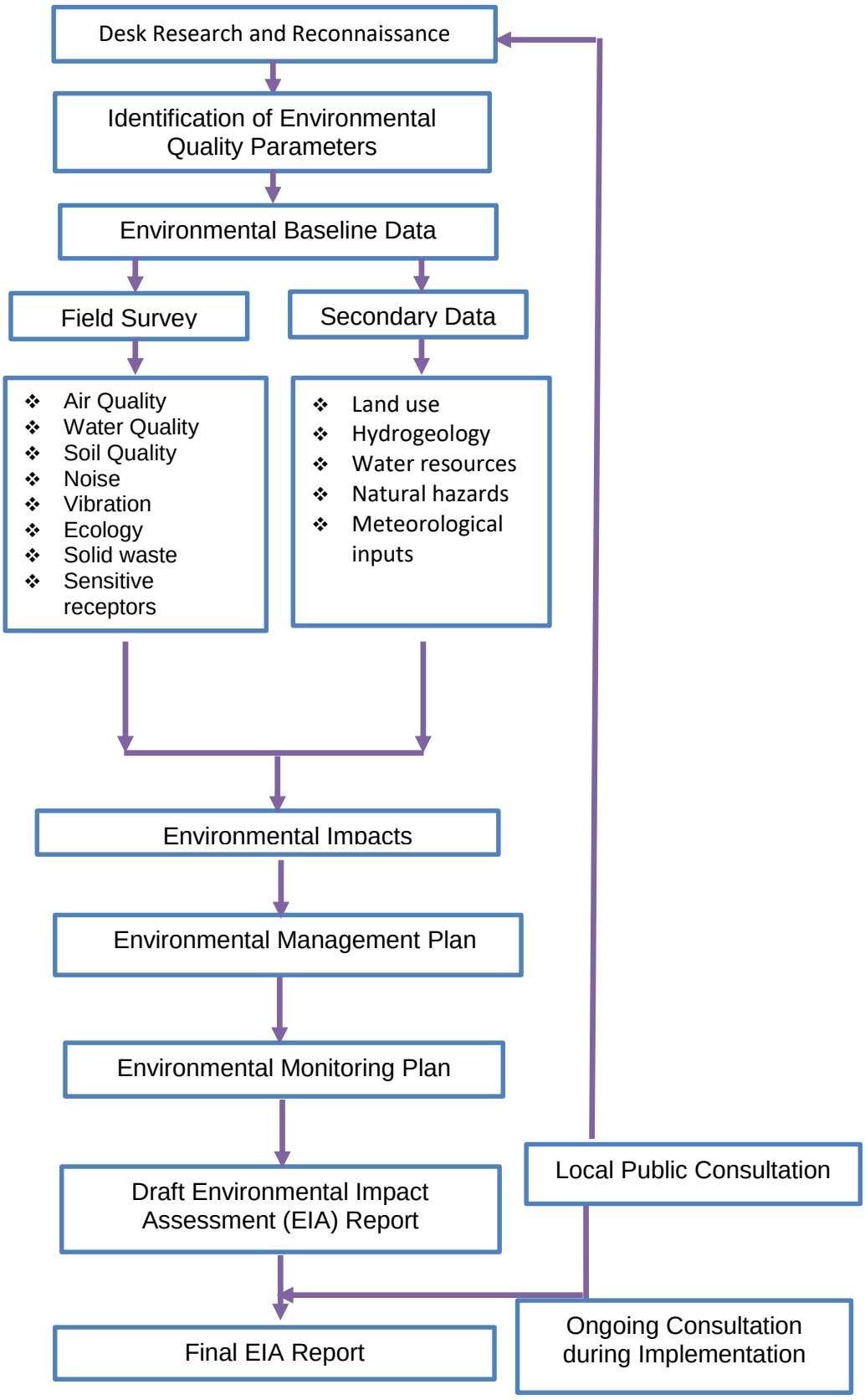
16. As shown in Figure 1.2, the EIA followed a number of steps:

- Review of available baseline reports, and technical reports/studies related to Balance C5;
- Conduct field visits to collect primary or secondary data relevant to Balance C5 areas to establish the baseline;
- Assess the potential impacts on environmental attributes due to the location, design, installation and operation of MDB Corridor 5 through field investigations and data analysis;
- Explore opportunities for environmental enhancement and identify measures;
- Prepare an Environment Management Plan (EMP) outlining the measures for mitigating the impacts identified;
- the implementation of Balance C5 and prepare an Environmental Monitoring Plan (EMoP);
- Propose the institutional arrangement to implement EMP and EMoP;
- Identify critical environmental parameters required to be monitored subsequent to
- Carry out consultation with key stakeholders and administrative authorities to identify their perception on Balance C5, introduce project components and anticipated impacts; and
- Disclose the draft EIA at CMRL and lenders' websites and prepare the Executive Summary in Tamil to be made publicly available.

17. The baseline data for air, water and soil quality was collected in width 75m on either side of proposed centre line of alignment, and data for noise and vibration in width 200m on either side of alignment. Sensitive receptors located in width 200m on either side of centre line of alignment were identified (Annexure 1) according to the silence zone defined by the Central Pollution Control Board (CPCB).

1.2.3 Approach and Methodology

Figure 1.2: Methodology of Environmental Impact Assessment



2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

18. India has well defined environment-related institutional and legislative framework. The legislation covers all components of environment viz. air, noise, water, soil, terrestrial and aquatic flora and fauna, natural resources, and sensitive habitats. India is also signatory to various international conventions and protocols. The environmental legislations in India are framed to protect the valued environmental components and comply with its commitment to international community under above conventions and protocols. MDBs have also defined its Environmental and Social Policies. This chapter will describe the applicability of above laws and regulations, conventions, protocols, and safeguards.

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

- National (India) Environmental Legislation and Legal Administrative Framework,
- ADB and AIIB environmental and social policies and standards, and
- Summary of international treaties and applicability to the project.

2.1 The National (India) Environmental Laws, Policies and Regulations

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

2.1.1 Forest Clearance applicable to the Project

21. 7,570 sqm of land area between Velakallu station and Medavakkam Koot Road Bus Stop station is located in the Nanmangalam Reserve Forest area for which diversion of land is required and it mandates forest clearance from the Regional Office of Ministry of Environment, Forests, and Climate Change **(**MoEF&CC, area less than 5ha).

2.1.2 Metro Rail Policy 2017

22. GoI's Union Cabinet approved a new Metro Rail Policy in 2017 that aims to enable the development and implementation of metro projects in a comprehensive and sustainable manner from the social, economic, and environmental perspectives. The Policy improves the integrated management of Metro development in three main aspects, (i) The new policy proposes that every city should setup a Unified Metropolitan Transport Authority for planning and developing multimodal transportation, which enable the overall planning and development of all modes of transport under the strong lead institutions; (ii) The need to carry out an alternative analysis is a welcome addition in the policy to help in better system selection; and (iii) The requirement to look at the 5-km catchment area for providing feeder services through walking, cycling and para-transit modes is promising.

2.1.3 Legislations Relevant to the Project

23. The policies and requirements which are most relevant in the context of this Corridor are provided in Table 2.1 below.

Table 2.1: Summary of Environmental Legislation Relevant to Balance C5

Legislation	Objective	Responsible Institution
Environment (Protection) Act (1986) and Rules (1986); National Conservation Strategy and Policy Statement on Environment and Development of 1992; National Environment Policy of 2006	To protect and improve the overall environment	MoEF&CC
Environmental Impact Assessment (EIA) Notification under Environmental Protection Rules (2006, 2009, 2011) and relevant Office Memorandums (OM)	To provide guidance on environmental clearance requirements and clarification on related specific technical issues	MoEF&CC
The Wildlife Protection Act (1972 and amended in 1993)	To protect wild animals and birds through the creation of National Parks and Sanctuaries	MoEF&CC
The Noise Pollution (Regulation and Control) Rules, 2000 (Amended 2002)	To provide for the prevention and control of noise pollution and for the establishment of Boards to carry out these purposes	Tamil Nadu State Pollution Control Board (TNSPCB)
Metro Rail Transit System, Guidelines for Noise and Vibrations, RDSO, Ministry of Railways, September 2015	To provide for the prevention and control of vibration	None notified
The Water (Prevention and Control of Pollution) Act 1972 (Amended 1988) and Rules 1974	To provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water	TNSPCB
The Tamil Nadu Water (Prevention and Control of Pollution) Rules, 1983 amended May 2009		
Model Groundwater (Control and Regulation) Bill 1970, amended in 1972, 1996 and 2005 The Tamil Nadu Groundwater (Development And Management) Act, 2003	To provide for the prevention, control and abatement of groundwater pollution	Central Ground Water Authority (CGWA) and Tamil Nadu Ground water Authority
The Air (Prevention and Control of Pollution) Act, 1981(Amended 1987) and Rules 1982	To provide for the prevention, control and abatement of air pollution, and for the establishment of Boards to carry out these purposes	TNSPCB for construction activities; Road Transport Authority for construction vehicles

Legislation	Objective	Responsible Institution
Municipal Solid Waste (MSW) Rules, 2000; Solid Waste Management Rules, 2016	Provisions for collection, storage segregation, transportation, processing and disposal of municipal solid wastes	TNSPCB
Hazardous and Other Wastes (Management and Transboundary Movement) Amendment Rules 2019	To protection the general public against improper handling, storage and disposal of hazardous wastes	TNSPCB
The Forest (Conservation) Act 1980 (Amended 1988) and Rules 1981 (Amended 2003)	To protect and manage forests	MoEF&CC
Construction and Demolition Waste Management Rules, 2016	Large generators (who generate more than 20 tons or more in one day or 300 tons per project in a month) shall submit waste management plan and get appropriate approvals from the local authority before starting construction or demolition or remodeling work	TNSPCB
The Mines and Minerals (Development and Regulation) Act, 1957	GoI Act: To regulate mining activities TN Rules: To regulate mining of minor minerals including building minerals To protect the environment from quarry operation	Department of Geology & Mining, GoTN
Central Motor Vehicle Act (1988)	To control vehicular air and noise pollution. To regulate development of the transport sector	Tamil Nadu State Transport Department
Indian Treasure Trove Act, 1878 (as modified up to September 1949); Ancient Monuments and Archaeological Sites and Remains Act (1958) updated as per Archaeological Sites and Remains (Amendment & Validation) Act 2010	Conservation of Cultural and historical remains found in India Chance finds during construction	Archaeological Survey of India
Annexure XXV, Special Rules for conservation of Heritage Buildings Vol II: Second Master Plan for Chennai Metropolitan Area 2026 amended May 2013	To protect heritage assets	CMDA
National Policy on HIV/AIDS and the World of Work	To regulate the safety, health and environment at workplace	Ministry of Labour and

Legislation	Objective	Responsible Institution
National Policy on Safety, Health and Environment at Workplace		Employment, GoI
Tamil Nadu Building and Construction Workers (Conditions of Employment and Miscellaneous Provisions) Act, 1984 Minimum Wages Act, 1948; Workmen's Compensation Act, 1923; The Contract Labour (Regulation & Abolition) Act, 1970 and Rules Employees State Insurance Act, 1948 (ESI); 8, The Payment of Wages Act, 1936, amended in 2005; The Tamil Nadu Labour Welfare Fund Act, 1972 The Equal Remuneration Act 1976; Workmen's Compensation Act, 1923	To regulate the employment and conditions of service of building and other construction workers and to provide for their safety, health and welfare measures	Department of Labour and Employment, GoTN
Interstate Migrant Workmen (Regulation of Employment and conditions of Service) Act 1979	In case workers and labourers working at the project sites are migrants from other states during construction	
Child Labour (Prohibition and Regulation) Act, 1986	To regulate the employment of children including age limits, type of employment, timing of work, information disclosure and health and safety	

2.1.4 Required Clearances/Permissions

24. As per GoI EIA Notification 2006, all railways projects in India are exempted from obtaining Environmental Clearance (EC), therefore EC for Balance C5 is not required. However, part of the alignment passes through Nanmangalam reserve forest, forest clearance for diversion of forest land (7,570 sqm) is required.

25. Before the start of civil works for any section of Balance C5, CMRL must obtain necessary clearances/permissions from statutory authorities. For implementation of Balance C5, required clearances/ permissions related to environment and labour safeguards have been summarized in Table 2.2.

Table 2.2: Applicable Permissions and Clearances Required for Balance C5

SN	Permissions/ Clearances	Acts/Rules/Notifications/ Guidelines	Concerned Agency	Responsibility
A. Pre-construction Stage				

SN	Permissions/ Clearances	Acts/Rules/Notifications/ Guidelines	Concerned Agency	Responsibility
1.	(i) Clearance to divert forest land to non-forest purposes (ii) Permission for felling of trees	Forest Conservation Act, 1980	Tamil Nadu Forest Department (TNFD). Tree felling permission is required only for Private forest or hill area or sandalwood trees: therefore separate permission not required for the project.	CMRL
2.	Building Permissions for stations and depots	Second Master Plan for Chennai Metropolitan Area 2026 amended May 2013	CMDA	Contractor and CMRL
B. Construction Stage				
3.	Consent to Establish & Operate for Ready Mix Concrete plant & casting yard	Air (Prevention and Control of Pollution) Act 1981	TNSPCB	Contractor engaged by CMRL To be obtained before installation
4.	Permission for withdrawal /dewatering of groundwater[1]	Chennai Metropolitan Area Groundwater (Regulation) Act, 1987 as amended till 2008 Guidelines/Criteria for evaluation of proposals/requests for ground water abstraction (With effect from 16.11.2015)	Head of Municipal Area (Greater Chennai Municipal Corporation) and CGWA	Contractor engaged by CMRL To be obtained before construction
5.	Consent to recharge groundwater with dewatering water if any	Water (Prevention and Control of Pollution) Act 1974 amended 1988, Environment (Protection) Amendment Rules, 2017 (Discharge Standard for Sewage Treatment Plants(STPs)), Model Groundwater (Control and Regulation) Bill 1970, amended in 1972, 1996 and 2005	Head of Municipal Area and CGWB/PWD	Contractor engaged by CMRL To be obtained before construction
6.	Authorization for storage (diesel) and disposal of Hazardous Waste	Hazardous and Other Wastes (Management& Transboundary Movement) Amendment Rules, 2019	TNSPCB	Contractor engaged by CMRL To be obtained

[1] The Contractor will avoid extraction of groundwater as much as possible. If not avoidable, the permission will be obtained prior to the extraction.

SN	Permissions/ Clearances	Acts/Rules/Notifications/ Guidelines	Concerned Agency	Responsibility
				before installation
7.	Consent for disposal of sewage from labour camps.	Water (Prevention and Control of Pollution) Act 1974 amended 1988 Environment (Protection) Amendment Rules, 2017 (Discharge Standard for Sewage Treatment Plants(STPs))	TNSPCB	Contractor engaged by CMRL To be obtained before installation
8.	Pollution Under Control Certificate for various vehicles use for construction	Central Motor and Vehicle Act, 1988	Department of Transport, Govt. of Tamil Nadu authorised testing centres	Contractor engaged by CMRL To be obtained before installation
9.	Employing Labour/ workers	The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996	Labour and Employment Department, GoTN	Contractor engaged by CMRL To be obtained before installation
10.	Roof Top Rainwater Harvesting (RWH)	Central Groundwater Authority (CGWA) Guidelines PWD rainwater harvesting guidelines	TNSPCB / PWD, GoTN	Contractor engaged by CMRL To be obtained before installation
11.	Permission for use of fresh water for construction and drinking purpose.	Environment (Protection) Act, 1986	Chennai Metropolitan Water Supply & Sewerage Board (CMWSSB)	Contractor engaged by CMRL To be obtained before installation
12.	Permission for Quarry Operation	The Mines and Minerals (Development and Regulation) Act, 1957	Department of Geology and Mining, GoTN	Contractor engaged by CMRL To be obtained before construction
13.	Authorization for Disposal of Construction and Demolition Waste	Construction and Demolition Waste Management Rules, 2016	TNSPCB	Contractor engaged by CMRL To be obtained before installation

SN	Permissions/ Clearances	Acts/Rules/Notifications/ Guidelines	Concerned Agency	Responsibility
14.	Consent to Establish labour camps, pre-casting and material yards, hot mix plant, crushers, batching plant, stations	Air, Water and Noise Regulations	TNSPCB	Contractor engaged by CMRL To be obtained before installation The Application forms for seeking Consent are available from the office of SPCB at Chennai.
15.	Consent to muck/waste disposal	Construction and Demolition Waste Management Rules, 2016 Solid Waste Management Rules, 2016	TNSPCB	Contractor engaged by CMRL To be obtained before installation
16.	Installation and operation of DG sets at stations	Air (Prevention and Control of Pollution) Act, 1981 amended 1987; CPCB Notification April 1994 of National Ambient Air Quality Standards	TNPCB	CMRL
17.	Information to Government and compliance for labour engagement, welfare, safety and health	Tamil Nadu Building and Construction Workers (Conditions of Employment and Miscellaneous Provisions) Act, 1984 Minimum Wages Act, 1948; Workmen's Compensation Act, 1923; The Contract Labour (Regulation & Abolition) Act, 1970 and Rules Employees State Insurance Act, 1948 (ESI); The Payment of Wages Act, 1936, amended in 2005; The Tamil Nadu Labour Welfare Fund Act, 1972; The Equal Remuneration Act 1976; Workmen's Compensation Act, 1923;	Labour and Employment Department, GoTN	Contractor

SN	Permissions/ Clearances	Acts/Rules/Notifications/ Guidelines	Concerned Agency	Responsibility
		Interstate Migrant Workmen (Regulation of Employment and conditions of Service) Act 1979; Child Labour (Prohibition and Regulation) Act, 1986		

2.1.5 Institutional Administrative Framework

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

27. **Ministry of Environment, Forests and Climate Change (MoEF&CC):** MoEF&CC is apex body in India responsible for protection and enforcement of laws and regulations. In view of the growing importance of environmental affairs, the Government of India set up a Department in November 1980 under the portfolio of the Prime Minister. The department, later renamed as the MoEF&CC plays a vital role in environmental management for sustained development and for all environmental matters in the country.

28. The major responsibilities of MoEF&CC includes, Environmental resource conservation and protection, Environmental Impact Assessment of developmental projects, Co-ordination with the other ministries and agencies, voluntary organizations and professional bodies on environmental action plans, Policy-planning, Promotion of research and development, manpower planning and training and creation of environmental awareness; Liaison and coordination with international agencies involved in environmental matters.

29. Developmental project proponents are also required to submit Environmental Impact Statements/Assessments to establish that preventive measures are planned by installing adequate pollution control and monitoring equipment, and that effluent discharged into the environment will not exceed permissible levels. The MoEFCC appraises these statements/ assessments and approves the project from the environmental angle.

30. **Tamil Nadu State Pollution Control Board (TNSPCB):** Tamil Nadu Pollution Control Board was formed under the provisions of section 4 of Water (Prevention & Control of Pollution) Act, 1974. The Board is also functioning as the State Board under section 5 of the Air (Prevention & Control of Pollution) Act, 1981. The prime objective of all these Acts is maintaining, restoring and preserving the wholesomeness of quality of environment and prevention of hazards to human beings and terrestrial flora and fauna.

31. **Central Ground Water Board (CGWB):** The CGWB is responsible for the development, dissemination of technologies, and monitoring of India's groundwater resources, including their exploration, assessment, conservation, augmentation, protection from pollution and distribution. The CGWB, under the Ministry of Water Resources, was established in 1970. Various activities related to regulation and control of ground water development in the country is the responsibility of the Central Ground Water Authority (CGWA) specifically constituted under the Environmental (Protection) Act, 1986. The CGWA has identified over exploited-areas across India where groundwater withdrawal is regulated. To date, 43 critical/ overexploited notified areas have been identified in 10 states. Construction of new ground water structures is prohibited in the notified areas while permission of drilling tube wells is being granted only to the government agencies responsible for drinking water supply.

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

33. The Tribunal's dedicated jurisdiction in environmental matters shall provide speedy environmental justice and help reduce the burden of litigation in the higher courts. The Tribunal is mandated to make and endeavour for disposal of applications or appeals finally within 6 months of filing of the same. Initially, the NGT is proposed to be set up at five places of sittings and will follow circuit procedure for making itself more accessible. New Delhi is the Principal Place of Sitting of the Tribunal and Bhopal, Pune, Kolkata and Chennai shall be the other four place of sitting of the Tribunal.

2.2 International and Regional Agreements and Conventions

34. India is member of almost all major Multilateral Environmental Agreements (MEAs), under four clusters, namely the following:

A. Nature conservation;
B. Hazardous material;
C. Atmospheric emissions; and
D. Marine environment.

35. The Nature conservation and Climate change agreements will be applicable to this Corridor.

A. Nature conservation

No.	Nature Conservation
1	Ramsar Convention on Wetlands
2	CITES (Convention on International Trade in Endangered Species of Fauna and Flora)
3	TRAFFIC (The Wildlife Trade Monitoring Network)
4	CMS (Convention on the Conservation of Migratory Species)
5	CAWT (Coalition Against Wildlife Trafficking)
6	CBD (Convention on Biological Diversity)
7	ITTC (International Tropical Timber Organisation)
8	UNFF (United Nations Forum on Forests)
9	IUCN (International Union for Conservation of Nature and Natural Resources)
10	GTF (Global Tiger Forum)

B. Hazardous material

No.	Hazardous material
1	Cartagena Protocol on Biosafety
2	SAICM (Strategic Approach to International Chemicals Management)
3	Stockholm Convention on Persistent Organic Pollutants (POPs)
4	Basel Convention on the Control of Trans-boundary Movement of Hazardous Waste and Their Disposal
5	Rotterdam Convention on Prior Informed Consent (PIC) for certain Hazardous Chemicals and Pesticides in International Trade

C. Atmospheric emissions

No.	Atmospheric emissions
1	UNFCCC (United Nations Framework Convention on Climate Change)
2	Kyoto Protocol
3	UNCCD (United Nations Convention to Combat Desertification)
4	Montreal Protocol (on Ozone Depleting Substances)

D. Marine environment

No.	Marine environment
1	IWC (International Whaling Commission)

2.3 MDBs' Requirements Applicable to the Project

36. MDBs' project planning activities related to environmental and social safeguards generally comprise, a) screening and categorization by Bank; b) due diligence of the project by Bank; c) environmental and social assessment by Borrower and its review by Bank; d) information disclosure by Borrower and Bank and consultation by Borrower; e) monitoring and reporting by Borrower and Bank; and f) grievances.

2.3.1 Safeguard Policy Statement (SPS) 2009 of ADB

37. ADB's SPS sets out the policy objectives, scope and triggers, and principles for three key safeguard areas:

i. Environmental Safeguards,
ii. Involuntary Resettlement Safeguards, and
iii. Indigenous Peoples Safeguards.

2.3.2 Environmental and Social Framework (ESF) 2019 of AIIB

38. ESF of AIIB comprises the following:

i. **Environmental and Social Policy (ESP).** This comprises mandatory environmental and social requirements for all investments.
ii. **Environmental and Social Standards.** Three associated mandatory environmental and social standards (ESSs) set out more detailed environmental and social requirements relating to the following:
    ESS 1: Environmental and Social Assessment and Management;
    ESS 2: Involuntary Resettlement; and
    ESS 3: Indigenous Peoples.

2.4 Applied Standards

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

- ✓ Air Quality
  - WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide *Global Update, 2005.(EHS Guidelines WBG April 2007)*
  - Environment (Protection) Seventh Amendment Rules 2009

  Air quality guideline values in terms of PM10,PM2.5 and SO2 are more stringent in WBG guidelines than Indian national standards.

- ✓ Water quality
  - Pollution Prevention and Abatement Handbook, WB 1998 / April 1999 for stormwater
  - General Standards of discharge for environmental pollutants Part A- Effluents, Schedule VI, Environmental Protection Rules 1986, MoEFCC, Government of India *In relation to Indian post-treatment inland surface water standards, WBG effluent discharge guideline values for toxic metals are more stringent; they prescribe coliform levels while Indian standards do not.*
  - Designated Best Use Classification of Surface water, CPCB 1978 for propagation of wildlife and fisheries
  - WHO Guidelines for Drinking Water Quality 2017
  - Drinking Water Specification IS 10500-2012, Bureau of Indian Standards *Drinking water standards as per WHO cover fewer substances than Indian standards.*

- ✓ Soil (in terms of permissible content in foods)
  - UK EA Soil Guideline Values cover hydrocarbons and toxic metals; EC Regulations 1881/2006, 629/2008 and 835/2011 cover toxic metals, nitrates, Persistent Organic Pollutants (POPs) and Polycyclic Aromatic Hydrocarbons (PAHs)
  - In India, Prevention of Food Adulteration Rules 1955 prescribe permissible limits of lead, copper, arsenic, zinc, cadmium, mercury, chromium, nickel.

- ✓ Noise
  - WHO Guidelines for Community Noise ca. 1999
  - The Noise Pollution (Regulation and Control) Rules, 2000 (Amended 2002)

- ✓ Vibration
  - Transit Noise and Vibration Impact Assessment Manual, Federal Transit Administration, September 2018
  - Transit Noise and Vibration Impact Assessment, US FTA, May 2006
  - Metro Rail Transit System Guidelines for Noise and Vibrations, RDSO, Sept 2015

- ✓ Biodiversity **(**IUCN Red List and Guidance Note 6 of IFC)
  - determine the biodiversity footprint of the project and whether there are no-go areas;
  - avert loss of biodiversity and ecosystems, and at a minimum sustaining current biodiversity values through avoiding impact on biodiversity and ecosystems or minimised through mitigation.

- ✓ Climate Change (IFI's Framework of a harmonised approach of GHG accounting)
  - Rational approach to resource use, including the most effective measures in the field of energy efficiency
  - Estimation of GHG emissions
  - Information on the climate change risks
- ✓ Occupational Health and Safety (World Bank Group)
- ✓ Community Health and Safety (World Bank Group)

3. PROJECT DESCRIPTION

3.1 Description of Balance C5

40. Balance C5 is the 29.142 km line connecting CMBT to Ok. Tho including 28 stations. CMBT forms part of Corridor 5 from Madhavaram to CMBT and Ok. Tho forms part of Corridor 3. The Balance C5 has 4 stations in common with Corridor 4. It provides interchange with Phase I Metro, Corridor 3 and Corridor 4, MRTS and suburban railway. It is proposed for financing by AIIB and ADB. Stations of the Balance C5 per the tender drawing (excluding the 4 common stations with Corridor 4) are depicted in in Table 3.1.

Table 3.1 List of Stations – Balance C5

No.	STATION NAME	CHAINAGE (M)	INTER-STATION DISTANCE (M)	ELEVATED/UG
1.	CMBT (Part of JICA C5)	16007	-	Elevated (140x21.95)
2.	Grain Market	17029	1022	Elevated (140x21.95)
3.	Sai Nagar Bus Stop	17793	764	Elevated (140x21.95)
4.	Elango Nagar Bus Stop	18711	918	Elevated (140x21.95)
5.	Mugalivakkam	23890	-	Elevated (140x21.95)
6.	DLF IT SEZ	25155	1265	Elevated (140x21.95)
7.	Sathya Nagar	26190	1035	Elevated (140x21.95)
8.	CTC	27391	1201	Elevated (140x21.95)
9.	Butt Road	28560	1169	Elevated (140x21.95)
10.	Alandur	29830	1270	Elevated (140x21.95)
11.	St. Thomas Mount	31100	1270	Elevated (140x21.95)
12.	Adambakkam	32060	960	Elevated (140x21.95)
13.	Vanuvampet	32791	731	Elevated (140x21.95)
14.	Puzhuthivakkam	33642	851	Elevated (140x21.95)
15.	Madipakkam	34572	930	Elevated (140x21.95)
16.	Kilkattalai	35472	900	Elevated (140x21.95)
17.	Echangadu	36404	932	Elevated (140x32.35)
18.	Kovilambakkam	37416	1012	Elevated (140x21.95)
19.	Vellakkal	38490	1074	Elevated (140x21.95)
20.	Medavakkam Koot Road	39652	1162	Elevated (140x32.35)
21.	Kamaraj Garden Street	40843	1191	Elevated (140x32.35)
22.	Medavakkam Jn.	41617	774	Elevated (140x21.95)
23.	Perumbakkam	42294	677	Elevated (140x21.95)
24.	Global Hospital	43283	989	Elevated (140x21.95)
25.	Elcot	44483	1200	Elevated (140x21.95)
26.	Balance C5 End	45320	-	-

Source: Detailed Design Consultant

41. Land use along the alignment is summarised in Table 3.2.

Table 3.2: Land use abutting the Alignment

Table 3.2: Land use abutting the Alignment Section / station	Landuse
CMBT to Mugalivakkam	Residential + street front retail
Mugalivakkam to Sathya Nagar	Large employment, commercial
Sathya Nagar to CTC	Residential + large employment commercial
CTC to Velakallu	Residential + Madras War Cemetery + street front retail
Vellakkal to Medavakkam Koot Road	Forest scrub; Nanmangalam lake in the reserve forest is located 1km away from alignment
Medavakkam Koot Road to Global Hospital	Residential
Perumbakkam / Global Hospital to Sholinganallur	Alignment passes through Pallikaranai wetland part of which is reserve forest; home and breeding ground to 350 species of flora and fauna. In principle silence zone. One large employment centre.

42. Topographical survey was carried out in detail using modern surveying instruments. The geotechnical investigations determined the required strength characteristics of the underlying soil/rock strata to design the foundation of the proposed structure. A total of 60 bore holes were drilled all along the Balance C5. Also, since the proposed site is located in seismic Zone III, suitable seismic measures will be adopted in the design of the structures.

43. The salient features of Corridor 5 Project are summarized in Table 3.3.

Table 3.3: Salient Features of Balance C5

Gauge (Nominal):	1435 MM
Route Length:	29.142 km fully elevated
Number of Stations:	28 all elevated (4 stations common with Corridor 4)
Speed:	
1. Design Speed	80 kmph
2. Maximum Design Speed	90 kmph
3. Schedule (Booked) Speed	32 kmph

Train Operation Plan * :

Particulars	2025	2035	2045	2055
Trains/hour (3 Car, 6 Car)	15 (11,4)	15 (5,10)	15 (0,15)	17 (0,17)
Head Way (Second)	240	240	240	212
Capacity (6p/m^2;8p/m^2)	14,730, 18,741	19,590 24,915	23,640 30,060	26,792 34,068
Max. PHPDT Demand	17,539	24,528	29,441	35714
Total Coach Requirement	90	126	156	192

* MMBT-CMBT-SLR

Traction Power Supply:

1. Traction System Voltage	25 kV AC
2. Current Collection	Overhead Electric Traction

3. Receiving Substations (RSSs)	4 RSS at Mugalivakkam, St Thomas Mount, Medavakkam, Perumbakkam

Power Demand (MVA) * :

Load	2025		2035		2045		2055	
	Normal	Emergency	Normal	Emergency	Normal	Emergency	Normal	Emergency
Thiruverkadu GSS-Mugalivakkam RSS (Chainage 7186 to 13366) 6.180km								
Traction	2.46	6.34	3.24	8.36	3.90	10.05	4.42	11.39
Auxiliary	5.13	7.70	6.38	9.40	7.18	10.70	7.70	11.55
Total	7.59	14.04	9.62	17.76	11.08	20.75	12.12	22.94
Alandur GSS-St Thomas RSS (Chainage 13366 to 23109) 9.743km								
Traction	3.88	8.59	5.11	11.33	6.15	13.62	6.97	15.44
Auxiliary	2.57	5.13	3.02	6.03	3.53	7.06	3.85	7.70
Total	6.45	13.72	8.13	17.33	9.68	20.68	10.82	23.14
Kadaperi GSS to Medavakkam RSS (Chainage 23109 to 34947) 11.838km								
Traction	4.71	9.22	6.21	12.16	7.47	14.62	8.47	16.57
Auxiliary	2.57	5.13	3.02	6.03	3.53	7.06	3.85	7.70
Total	7.28	14.35	9.23	18.19	11.00	21.68	12.32	24.27
Mambakkam GSS to Perumbakkam RSS (Chainage 34947 to 46272) 11.325km								
Traction	4.51	9.22	5.94	12.16	7.15	14.62	8.10	16.57
Auxiliary	2.57	5.13	3.02	6.03	3.53	7.06	3.85	7.70
Total	7.28	14.35	9.23	18.19	11.00	21.68	12.32	24.27

*composite ToP

Rolling Stock:

1. Rolling Stock with light weight Stainless Steel/Aluminum Body
2. Max. Axle Load 16 T
3. Dimensions L22.6 x W2.9m x H3.9m

Maintenance Facilities: No separate Depot

Signalling, Telecommunication and Train Control:

1. Type of signalling	Communication based Train Control System (CBTC) with unattended train operation permitting an operational headway of 90 seconds.
2. Telecommunication	Integrated System with Optic Fiber cable, Supervisory Control and Data Acquisition (SCADA), Close Circuit Television (CCTV), Central Voice Recording System (CVRS) etc.

Fare Collection:

Automatic Fare Collection (AFC) System with smart card/token etc.

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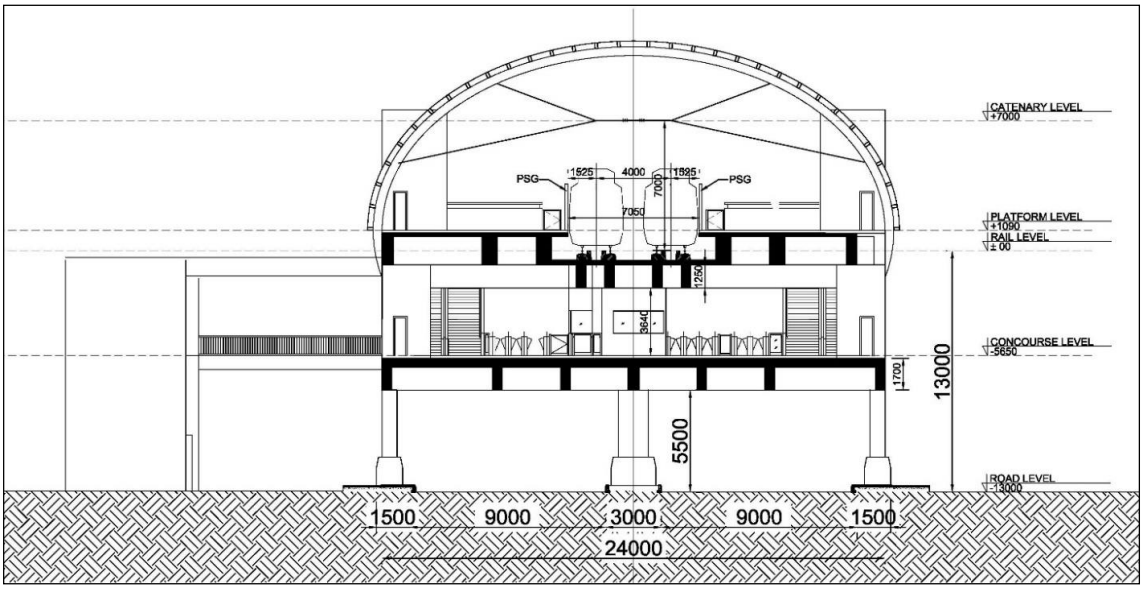
44. Elevated stations located at the median of existing roads will be 140 m long and 24 m wide. The stations will be constructed using the cantilever method. The typical elevated station consists of three levels: ground, concourse and platform. Passenger facilities, operational and commercial areas are provided at the concourse level. Platforms will be at a level of 13 m and concourse floor at about 7 m above the road, with a minimum of 5.5 m of vertical clearance under the concourse. To reduce physical and visual impact,

stations will be transparent with minimum walls on the sides. Figure 3.1 shows the typical elevated station.

Figure 3.1: Typical Elevated Station



Source: Detailed Project Report for Chennai Metro Rail Phase II corridors, February 2017

Labour Camp

45. The Contractor during the progress of work, will provide, erect and maintain necessary (temporary) living accommodation and ancillary facilities for labour. Contractor will establish construction camps as part of the project. Emphasis will be given to use existing facilities (established under ongoing lines). However, locations of the camps will be finalized after mobilization of contractor and in consultation with CMRL. The Contractor engaged by CMRL will also coordinate with the development authority for land use clearance, TNSPCB and Municipal Corporation to establish the labour camps before construction.

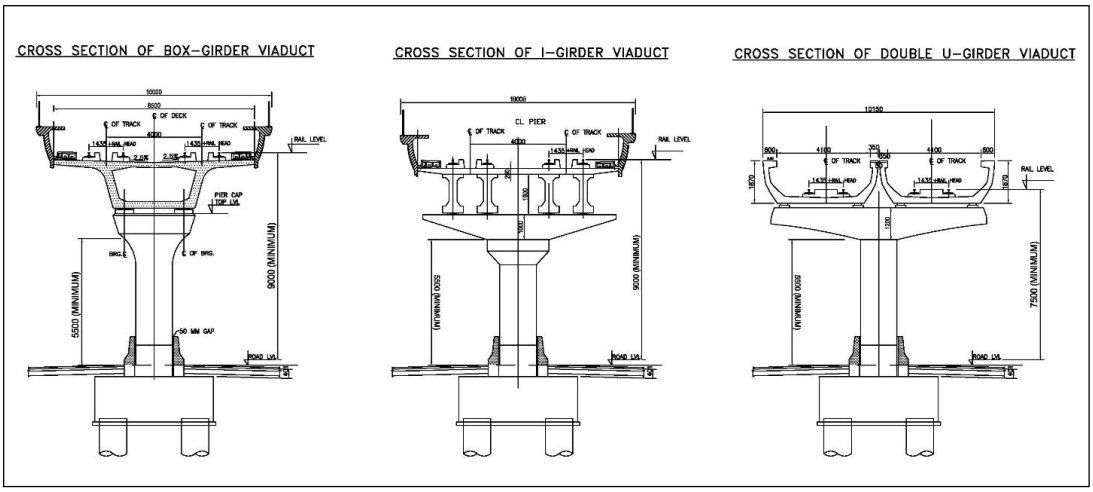
Construction Activities and Methodology

46. Main construction activities include demolition of structures and ground clearing; excavation/ cut and fill; Transport of construction materials, muck and waste; casting of concrete elements and preparation of concrete and their transportation; Pile driving where cast-in-situ is not feasible, blasting in rock etc.

47. Elevated Sections. Substructure - open foundation, pile, pile caps, columns; station structure; earth retaining structures shall be cast-in-situ. The structural elements for superstructure i.e. box segments, I-Girders, U-girders and sometimes pile caps are pre-cast. Pre-cast construction may be segmental or non-segmental type. In case of segmental method, structural segments are pre-casted in casting yards, pre-stressed and then transported to the location of use and launched by means of suitable launching arrangement. The construction yard has arrangement for casting beds, curing and stacking area, batching plant with storage facilities for aggregates and cement, site testing laboratories, reinforcement steel yard and fabrication yard etc. An area of about 3 ha is required for each construction yard.

48. The typical viaduct is shown in Figure 3.2.

Figure 3.2: Typical superstructure of viaduct



Source: Detailed Project Report for Chennai Metro Rail Phase II corridors, February 2017

3.2 Associated Facilities

49. Associated facilities are those that are not included or funded by the Project but are: (i) directly and materially related to the Project; (ii) carried out or planned to be carried out, contemporaneously with the Project; and (iii) necessary for the Project to be viable and would not be constructed or expanded if the Project did not exist.

50. The remaining section of the Corridor 5, which starts from Madhavaram to CMBT financed by JICA constitutes one of the Associated Facilities to Balance C5. A due diligence of sensitive locations was conducted. The avoidance and mitigation measures have been incorporated in the EMP.

51. From chainage 31300 to chainage 31700 after St. Thomas Mount Station, Southern Railways and CMRL agreed to take up their structures constructed within the same right of way available with MRTS. This stretch has been assessed as part of this EIA. Though not fully constitute the associated facility, to have a closer association and review the works as per the specifications, it is agreed to have joint meetings on quarterly basis to review the safeguard performance and documentations (Annexure 2).

52. The construction and operation of Balance C5 will require power and water from existing electricity grid and water supply system. Electricity is required for operation of Metro system for running of trains, station services ((e.g. lighting, lifts, escalators, signalling & telecom, firefighting etc. within premises of metro system). The power requirements of a metro system are determined by peak-hour demands of power for traction and auxiliary applications. These existing grid substations and water supply network are being operated and managed by respective agencies under full compliance with state and local policies and regulatory frameworks.

53. Chennai City has 230kV, 110kV, 33kV power transmission and distribution network to cater to various types of demand in the vicinity of proposed corridor. Keeping in view of reliability requirements of the corridor, four RSSs are proposed to avail power supply for traction as well as auxiliary services from Tamil Nadu Transmission Corporation Limited grid sub-stations at 110kV voltage through transmission lines or cable feeders for Corridor 5. M/s Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO) has confirmed the availability of supply.

54. Gas Insulated Substation (GIS) type substations, which offer the advantage of considerable saving in space requirement as well as reduced maintenance, are proposed for each Receiving cum Traction Substation and Auxiliary Substations of Balance C5. Each elevated station shall be provided with an Auxiliary Substation with two 33kV/415V, 3-phase, 500 kVA dry type cast resin transformers and the associated HT & LT switchgear. In addition, provision shall be made for one DG set at each station for emergency loads. In addition, it is proposed to provide standby DG set of 250 kVA at all elevated stations to cater to all emergency loads. Power Demand is estimated in Table 3.3.

55. During construction, water consumption will be of the order of 448 KLD for construction and 692 KLD for labour camps. During operation, the water demand at stations for cleaning is 481 KLD.

56. Water for dust suppression (sprinkling) and tire washing will be sourced from surface runoff, wastewater from construction sites, construction yards and seawater. Used water from tyre washing will be re-used. Water for curing of concrete will be sourced from municipal supply, surface runoff or water from dewatering. Water for concrete batching plant and labour camps will be sourced from treated municipal water.

57. After precipitation, waste water from construction yards, sites and labour camps will be discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. In view of the distributed nature of the linear construction and quantities of waste water, it is not proposed install sewage and effluent treatment plants by CMRL.

58. The water requirement for the stations will be met through the public water supply system. Municipal water supply will be supplemented by rainwater harvesting at elevated stations.

3.3 Implementation Plan, Schedule and Cost

59. Balance C5 will be implemented under design consultant and civil work contracts. There will be several packages for different components such as civil works contracts, detailed design, system contracts, supply and installations, rolling stocks etc. It is estimated that project will be commissioned 53 months from award of civil works. Table 3.4 shows the detailed schedules of the two civil work packages. The capital cost of Balance C5 including taxes and duties for December 2018 is estimated at USD 1,037 million.

Table 3.4: Implementation Schedule

(As of Feb 2021)

CMRL - PHASE II - Implementation Schedule (C5-ECV02)

Date : 23-Feb-21

S.No	Activity	Start	Finish	Remarks
	C5-ECV02 - CMBT to Puzhuthivakkam			
	Pre Construction			
1	Notice For Invitation		22-Jan-21	Completed
2	Pre Bid Meeting, Queries , Addendum and Bid Submission	23-Jan-21	27-May-21	
3	Bid Opening		28-May-21	
4	Technical , Financial Evoluation & issue of LOA	29-May-21	25-Aug-21	
5	Contract Commencement		22-Sep-21	
	Construction - Civil Works			
	Viaduct			
6	Submission of Initial works programme Establishment of site office.	23-Sep-21	20-Oct-21	
7	Establishment and Commissioning of Batching Plant and submission of Detail works programme.	21-Oct-21	01-Dec-21	
8	Commencement of Barricading and obtaining approvals for Traffic diversion.	23-Sep-21	01-Dec-21	
9	Completion of the initial pile load tests	01-Dec-21	05-Jan-22	
10	Completion of first working pile	05-Jan-22	12-Jan-22	
11	Completion of 50% working piles	12-Jan-22	18-May-22	
12	Completion of 100% working piles	18-May-22	24-Aug-22	
13	Completion of first Pile Cap	29-Dec-21	09-Feb-22	
14	Completion of 50% pile caps	09-Feb-22	15-Jun-22	
15	Completion of 100% pile caps	15-Jun-22	21-Sep-22	
16	Casting of first Pier	23-Feb-22	09-Mar-22	
17	Completion of 50 % Piers	09-Mar-22	13-Jul-22	
18	Completion of 100 % Piers	13-Jul-22	19-Oct-22	
19	Establishing Casting Yard with prestressing arrangements, handling equipment and formwork/moulds ready for production of precast elements.	01-Dec-21	09-Mar-22	
20	Casting of first pre-cast pier-cap at casting yard for approval of formwork and casting beds by Engineer.	10-Mar-22	06-Apr-22	
21	Casting of 50% pre-cast pier-cap at casting yard	07-Apr-22	10-Aug-22	
22	Casting of 100% pre-cast pier-cap & cast insitu pier caps	11-Aug-22	14-Dec-22	
23	Completion of Casting of 100% I-Girders	06-Apr-22	24-Aug-22	
24	Casting of first U-girder at casting yard for approval of formwork and casting beds by Engineer.	06-Apr-22	04-May-22	
25	Casting of 50% U girder at casting yard	05-May-22	01-Mar-23	
26	Casting of 100% U girder at casting yard	02-Mar-23	23-Aug-23	
27	Erection of first Pier Cap	04-May-22	18-May-22	
28	Erection of 50% Pier Cap	19-May-22	05-Oct-22	
29	Erection of 100% Pier cap	06-Oct-22	08-Feb-23	
30	Completion of Precast & Cast in-situ Portal frames	06-Apr-22	19-Oct-22	
31	Commencement of Fabrication of Launching Girders	19-Feb-22	20-Apr-22	
32	Erection of Launching Girders	21-Apr-22	15-Jun-22	
33	Erection of first U-girder using Launching Girder	28-Apr-22	29-Jun-22	
34	Erection of 50% U girder	30-Jun-22	05-Apr-23	
35	Erection of 100% I-girder	18-Aug-22	16-Nov-22	
36	Erection of 100% U girder	06-Apr-23	01-Nov-23	
37	Partial access of Viaduct for track (Approx. 4 km with Continuous stretch)		14-Jun-23	
38	Partial access of Viaduct for track (Approx. 4 km Continuous stretch & cumulatively 8 km stretch)		27-Sep-23	
39	Partial access of Viaduct for track (Balance stretch)		10-Jan-24	
40	Partial access of Viaduct to E&M contractor along with cable tray supports and all associated works (Approx. 4 Km stretch)		19-Jul-23	
41	Partial access of Viaduct to E&M contractor along with cable tray supports and all associated works (Approx. 4 Km stretch)		01-Nov-23	
42	Partial access of Viaduct to OHE and E&M contractor along with cable tray supports and all associated works (Balance 4 Km stretch).		14-Feb-24	
43	Completion of all works of Viaduct including all ancillary works		20-Mar-24	
	STATION			
44	Piling & Pile Cap Works	06-Jan-22	24-Aug-22	
45	Construction of Pier upto Concourse Lvl	25-Jun-22	21-Sep-22	
46	Construction of Pier upto Pier Cap Lvl	25-Jul-22	19-Oct-22	
47	Structural works upto Concourse Lvl	23-Sep-22	08-Feb-23	
48	Structural works upto Platform Lvl	22-Dec-22	28-Jun-23	
49	Station Roof Structure	28-Jun-23	29-Nov-23	
50	Entry/ Exit Structure - Foundation	18-Aug-22	16-Nov-22	
51	Entry/ Exit Structure - Structural Works	17-Nov-22	14-Jun-23	
52	Entry/ Exit Structure - Sump & Pump Room	18-Aug-22	05-Apr-23	
53	Architectural Finishing works - Concourse Lvl	01-Mar-23	20-Mar-24	
54	Architectural Finishing works - Platform Lvl	19-Jul-23	29-May-24	
55	Architectural Finishing works - Entry/Exit	15-Jun-23	20-Mar-24	
56	Access to Track Contractor		14-Jun-23	
57	Access to M&E Contractor		14-Jun-23	
58	Access to S&T Contractor		19-Jul-23	
59	Access to Traction (PS&OHE) Contractor		20-Sep-23	
60	Access to Lift, Escalator , AFC Contractor		20-Mar-24	
61	Track Installation	14-Jun-23	09-May-24	

S.No	Activity	Start	Finish	Remarks
62	System Installation	14-Jul-23	06-Sep-24	
63	Integrated Testing and Commissioning	07-Sep-24	07-Feb-25	
64	CMRS	07-Feb-25	07-Apr-25	
65	ROD		08-Apr-25	

CMRL - PHASE II - Implementation Schedule (C5-ECV03)

Date : 23-Feb-21

S.No	Activity	Start	Finish	Remarks
	C5-ECV03 - Puzhuthivakkam (Excluding Station) to Elcot			
	Pre Construction			
1	Notice For Invitation		12-Nov-20	Completed
2	Pre Bid Meeting, Queries , Addendum and Bid Submission	13-Nov-20	16-Mar-21	
3	Bid Opening		17-Mar-21	
4	Technical , Financial Evoluation & issue of LOA	18-Mar-21	14-Jun-21	
5	Contract Commencement		12-Jul-21	
	Construction - Civil Works			
	Viaduct			
6	Submission of Initial works programme Establishment of site office.	13-Jul-21	09-Aug-21	
7	Establishment and Commissioning of Batching Plant and submission of Detail works programme.	10-Aug-21	20-Sep-21	
8	Commencement of Barricading and obtaining approvals for Traffic diversion.	13-Jul-21	20-Sep-21	
9	Completion of the initial pile load tests	20-Sep-21	25-Oct-21	
10	Completion of first working pile	25-Oct-21	01-Nov-21	
11	Completion of 50% working piles	01-Nov-21	07-Mar-22	
12	Completion of 100% working piles	07-Mar-22	13-Jun-22	
13	Completion of first Pile Cap	18-Oct-21	29-Nov-21	
14	Completion of 50% pile caps	29-Nov-21	04-Apr-22	
15	Completion of 100% pile caps	04-Apr-22	11-Jul-22	
16	Casting of first Pier	13-Dec-21	27-Dec-21	
17	Completion of 50 % Piers	27-Dec-21	02-May-22	
18	Completion of 100 % Piers	02-May-22	08-Aug-22	
19	Establishing Casting Yard with prestressing arrangements, handling equipment and formwork/moulds ready for production of precast elements.	20-Sep-21	27-Dec-21	
20	Casting of first pre-cast pier-cap at casting yard for approval of formwork and casting beds by Engineer.	28-Dec-21	24-Jan-22	
21	Casting of 50% pre-cast pier-cap at casting yard	25-Jan-22	30-May-22	
22	Casting of 100% pre-cast pier-cap & cast insitu pier caps	31-May-22	03-Oct-22	
23	Completion of Casting of 100% I-Girders	24-Jan-22	13-Jun-22	
24	Casting of first U-girder at casting yard for approval of formwork and casting beds by Engineer.	24-Jan-22	21-Feb-22	
25	Casting of 50% U girder at casting yard	22-Feb-22	19-Dec-22	
26	Casting of 100% U girder at casting yard	20-Dec-22	12-Jun-23	
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33	Erection of first U-girder using Launching Girder	15-Feb-22	18-Apr-22	
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36	Erection of 100% U girder	24-Jan-23	21-Aug-23	
37	Partial access of Viaduct for track (Approx. 4 km with Continuous stretch)		03-Apr-23	
38	Partial access of Viaduct for track (Approx. 4 km Continuous stretch & cumulatively 8 km stretch)		17-Jul-23	
39	Partial access of Viaduct for track (Balance stretch)		30-Oct-23	
40	Partial access of Viaduct to E&M contractor along with cable tray supports and all associated works (Approx. 4 Km stretch)		08-May-23	
41	Partial access of Viaduct to E&M contractor along with cable tray supports and all associated works (Approx. 4 Km stretch)		21-Aug-23	
42	Partial access of Viaduct to OHE and E&M contractor along with cable tray supports and all associated works (Balance 4 Km stretch).		04-Dec-23	
43	Completion of all works of Viaduct including all ancillary works		08-Jan-24	
	STATION			
44	Piling & Pile Cap Works	26-Oct-21	13-Jun-22	
45	Construction of Pier upto Concourse Lvl	14-Apr-22	11-Jul-22	
46	Construction of Pier upto Pier Cap Lvl	14-May-22	08-Aug-22	
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55	Architectural Finishing works - Entry/Exit	04-Apr-23	08-Jan-24	
56	Access to Track Contractor		03-Apr-23	
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58	Access to S&T Contractor		08-May-23	
59	Access to Traction (PS&OHE) Contractor		10-Jul-23	
60	Access to Lift, Escalator , AFC Contractor		08-Jan-24	
61	Track Installation	03-Apr-23	27-Feb-24	

S.No	Activity	Start	Finish	Remarks
62	System Installation	03-May-23	26-Jun-24	
63	Integrated Testing and Commissioning	27-Jun-24	27-Nov-24	
64	CMRS	27-Nov-24	25-Jan-25	
65	ROD		26-Jan-25	

4. ENVIRONMENTAL BASELINE

60. The collection of current baseline information on physical, ambient, ecological and socioeconomic environment of the project area of influence, provides an important reference for conducting an EIA. The description of environmental settings includes the characteristic of area in which the project activities would occur and likely to be affected by project related impacts. Compiled existing baseline conditions include primary data on air quality, water quality, noise, soil, ecology and biodiversity, and socioeconomic aspects. Secondary data were also collected from published sources such as Indian Meteorological Department (IMD), NGO reports on ecology, press reports on water availability,

4.1 Data Collection Methodology

61. The data on water, air, and soil were collected through field monitoring conducted in 2016 and 2019. The noise and vibration data were further elaborated in 2019 and the modeling study is ongoing to include the sensitive receptors along the Balance C5. Data on biodiversity was collected through the field studies in May 2018. Meteorological data was collected from IMD. Efforts have been made to compile the available data from literature, books, maps and reports. The methodology adopted for data collection is highlighted wherever necessary. Environmental attributes and samplings of baseline surveys are presented in Table 4.1 and monitoring locations are presented in Table 4.2 and Figure 4.2. The detailed analysis reports received from the monitoring laboratory are provided in Annexure 7, whereas summary from the reports are discussed in respective sections.

62. MoEF&CC OM No. J-11013/41/2006-1A-11 (I) (Part) dated 29th August, 2017 pertains to projects/activities requiring EC under EIA Notification, 2006. This project is not listed among activities/projects requiring EC. Moreover, treatment of water, waste water is not among the project activities – it will be done by municipal authorities. Treatment and safe disposal of surplus soil if any will be done by the Contractor as provided for in EMP: Contractor will collect baseline soil and groundwater quality data once prior to operation of the plants and quarterly during construction. After Construction, Contractor will conduct soil and groundwater analysis and be obliged to reinstate the used sites no worse than the conditions of pre-construction. In addition to monitoring of air quality pre-construction and during construction, measures to mitigate air pollution which have been specified in the EMP and approved by CMRL will be implemented during construction. Thus, adequate provision has been made in the EMP and EMoP to address pollution due to all constituents of air, water and soil notwithstanding values measured for this report.

Table 4.1 Environmental Attributes and Data Source

Sl. No	Attribute	Parameter	No. of Samples	Source
Physical Environment				
1.	Geology	Geological Status	---	Literature review
2.	Seismology	Seismic Hazard	---	Literature review
3.	Climate	Climate Parameters	---	IMD
4.	Soil Quality	Physico-chemical parameters	7	Sampling/ Monitoring locations
Ambient Environment				
5.	Water Quality	Physical, Chemical and Biological parameters	6 (Groundwater) Global Hospital (Surface)	Sampling/ Monitoring locations
6.	Ambient Air Quality	PM_{10}, $PM_{2.5}$, SO_2, NO_2 and CO	7	Sampling/ Monitoring locations

Sl. No	Attribute	Parameter	No. of Samples	Source
7.	Noise	Noise levels in dB (A) Lmax, Lmin, Leq, L_{10}, L_{50}, L_{90}	4 by landuse + 10 (Sample Sensitive Receptors)	Sampling/ Monitoring locations
8.	Vibration	Peak Particle Velocity in mm/s	2 by landuse + 6 (Sample Sensitive Receptors)	Sampling/ Monitoring locations
Ecological Environment				
9.	Trees	Number	Once	Field Studies
10.	Flora and Fauna	Sightings	Once	Literature review
Socio-Economic Environment				
11.	Socio-economic aspects	Socio-economic profile	Once	Field Studies by Social Team, Literature review.

Table 4.2: Details of Sampling / Monitoring Locations*

S. No	Distance from Sampling Location to Alignment	Land Use**
5C	Alwar Thiru Nagar junction, 7m A,W,S,N	Residential+ commercial
5D	MIOT Hospital, 18m A,W,S,N	Industrial
5E	Medavakkam Junction, 30m A,W,S,N	Residential
5F	Global Hospital, 38m (700m from hospital) A,W,S,N	Residential
5G	Kalpana Hospital, Adambakkam MRTS, 1m A,W,S	Residential
5H	Madipakkam Koot Road, 10m A,W,S	Residential+ Commercial
5I	Velakallu Bus Stop, 7m A,W,S	Residential+ Commercial

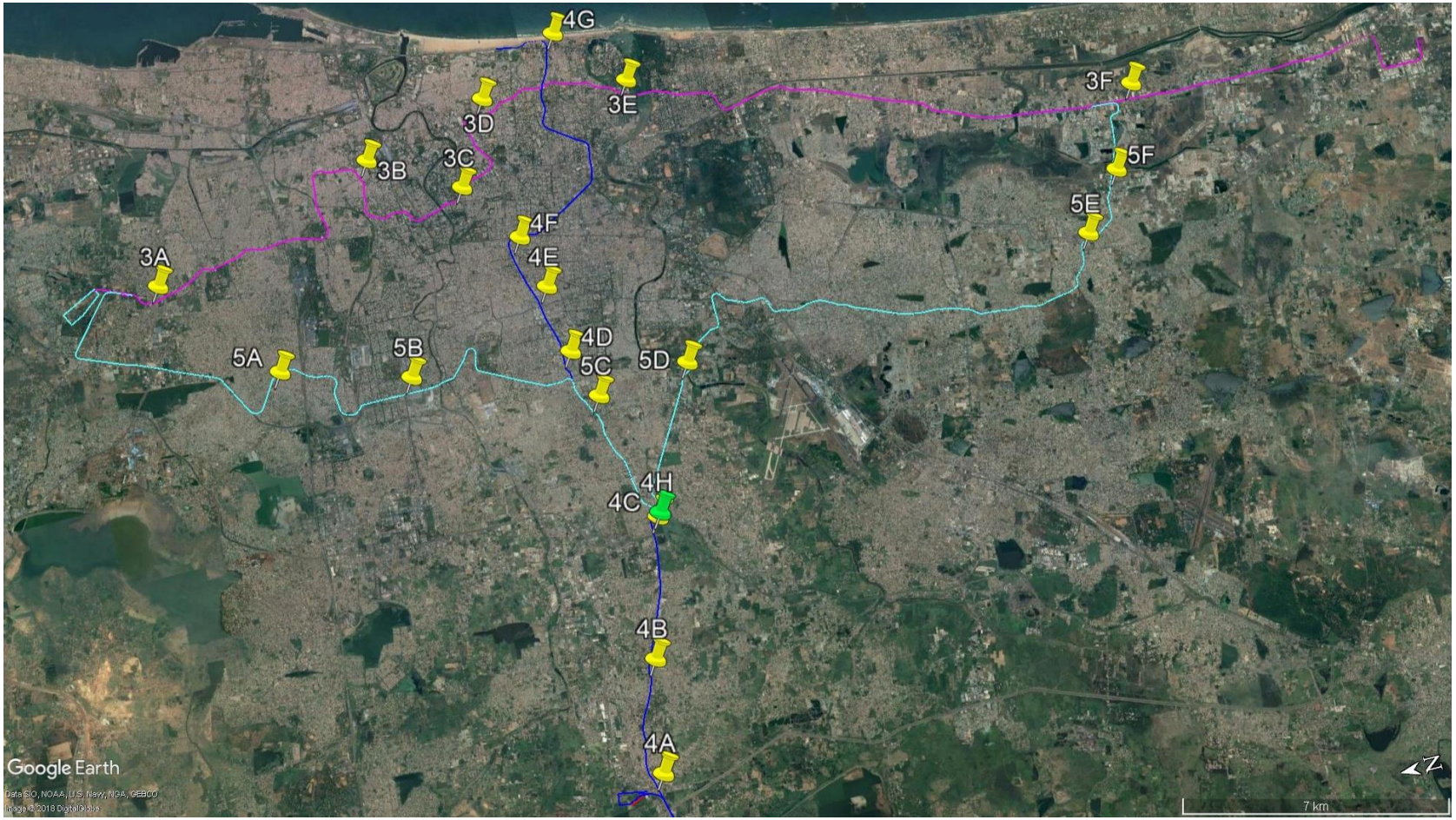
A: Air, W: Water; S: Soil, N: Noise
**Locations for noise and vibration at sensitive receptors are listed under Table 4.17 and Table 4.19 respectively.*
***As per CPCB guideline which is presented under Noise Section.*

63. A further 213 environmentally sensitive receptors located within 200m on either side of alignment as listed in Annexure 1 have been identified from site reconnaissance, comprising educational centres, religious places, hospitals and courts of law. To elaborate the baseline, a full set of baseline of air, water (surface and ground), soil, noise and vibration will be collected prior to the construction commencement.

64. Locations of sampling for air, water and soil quality are depicted in Figure 4.1. Soil quality is presented in Table 4.3.

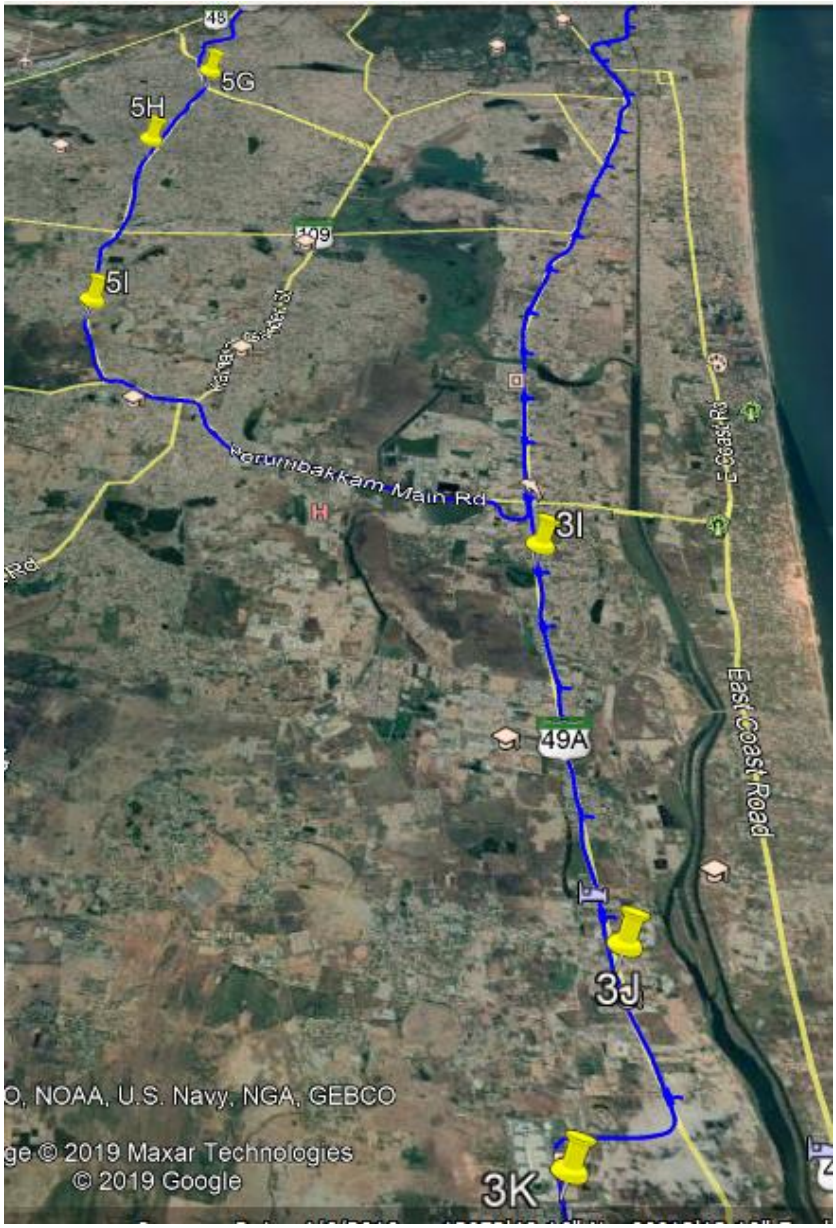
65. Sampling locations were selected to represent land use along the alignment namely commercial, residential and silence zone under religious and educational uses. The baseline information is categorized as physical, ambient, ecological and socioeconomic environment with depiction in following sections.

Figure 4.1 Monitoring Locations –Soil, Air, Water and Noise Part 1 by landuse



4 locations 5C to 5F; Field Survey: July 2016

Monitoring Locations - Soil, Air, Water Part 2 by Landuse



3 locations 5G to 5I; Field Survey: Nov/Dec 2019

4.2 Physical Environment

4.2.1 Physiography

66. Chennai is located on the South–Eastern coast of India in the North–Eastern part of Tamil Nadu. It is situated on a flat coastal plain that's why it is also known as the Eastern Coastal Plains. The study area is lies between Latitude of 13° 10' N to 12° 49' N and Longitude of 80° 10' E to 80° 14' E. Chennai is a low-lying area and the land surface is almost flat. It rises slightly as the distance from the sea-shore increases but the average elevation of the city is not more than 3 m above mean sea-level, while most of the localities are just at sea-level and drainage in such areas remains a serious problem. The topographical setting of project area is shown in Figure 4.2.

Figure 4.2 Topographical setting of Project Area

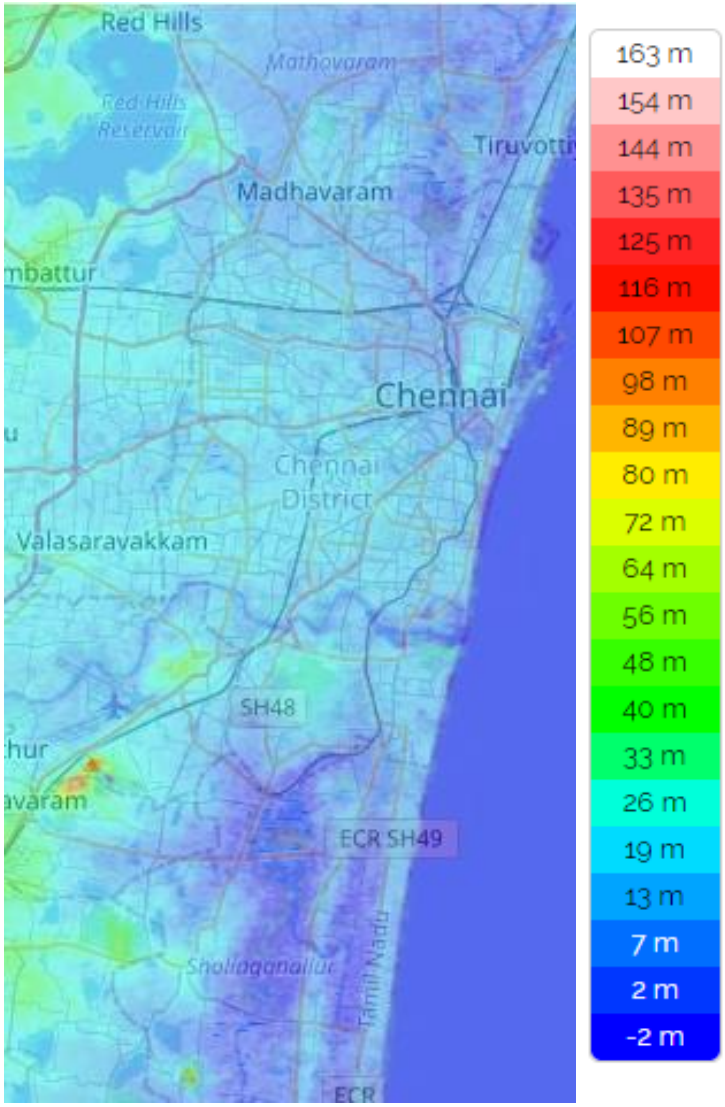


Table 4.3 Results of Laboratory Analysis of Soil Sample

S. No.	Parameter	Unit	5C	5D	5E	5F	5G	5H	5I
1	pH (at 25^0C)		7.11	7.75	7.86	7.28	6.15	5.34	5.94
2	Conductivity (1:2 soil water sus.)		0.19	0.22	0.25	0.17	102	35	61
3	Chloride	mg/kg	24.79	33.37	19.11	47.67	42.6	18.3	68.3
4	Available Phosphorous	Kg/hec	28.24	25.83	23.97	22.16	0.28	0.31	0.51
5	Total Zinc as Zn	mg/kg	12.35	12.37	13.20	14.36	14.2	32.2	16.2
6	Manganese as Mn	mg/kg	166.32	190.32	118.37	197.08	15	16.2	14.3
7	Total Lead as Pb @	mg/kg	9.65	10.77	11.40	8.78	BDL(DL :0.1)	BDL(DL:0.1)	BDL(DL:0.1)

8	Total Copper as Cu	mg/kg	14.82	19.45	16.23	16.88	22.3	24.3	14.3
9	Organic Carbon	%	0.73	0.63	0.59	0.66	0.92	0.84	0.86
10	Water Soluble Sulphate	mg/kg	20.12	18.99	22.53	27.64	145	82	16.3
11	Boron	mg/kg	1.86	2.27	1.76	1.33	0.039	5813	9563
12	Iron	mg/kg	420.37	448.5	428.23	455.64	245	318	184
13	Nickel	mg/kg	18.27	20.18	18.21	20.02	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
14	Bicarbonate	mg/kg	125.69	138.62	126.35	126.36	24.3	16	32
15	Calcium	mg/kg	140.09	160.24	86.82	76.28	17.1	7.39	27.4
16	Magnesium	mg/kg	27.28	27.98	22.36	20.36	24.6	38.6	44.3
17	Sand	%	34.93	31.97	35.17	35.78	53.5	51.7	44.4
18	Silt	%	38.88	39.05	39.06	37.66	28.5	26.3	32.6
19	Clay	%	28.19	28.98	26.77	28.56	18	22	23
20	Sodium	mg/kg	56.45	45.55	47.45	42.32	1458	2154	1436
21	Potassium	kg/hec	70.18	78.03	98.53	92.76	45.6	98	148
22	Sulphur	mg/kg	29.18	26.78	26.27	19.27	48.4	27.4	5.46
23	Organic Matter	%	1.26	1.08	1.03	1.05	1.6	1.45	1.84
24	Orthophosphate	mg/kg	70.65	67.08	73.91	76.20	794	214	12.3
25	Carbonate	mg/kg	2.99	5.01	5.03	3.88	18.6	12.6	14
26	Arsenic	mg/kg	BDL	BDL	BDL	BDL	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
27	Mercury	mg/kg	BDL	BDL	BDL	BDL	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
28	Cadmium as Cd	mg/kg	1.24	1.66	1.31	1.36	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
29	Molybdenum	mg/kg	0.60	0.82	0.69	0.63	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
30	Available Nitrogen	Kg/hec	199.97	305.36	268.66	264.53	5250	14	24

** As per Bureau of Indian Standards. The rest are as per ISO Soil Standards.*
4 locations 5C to 5F July 2016, 3 locations 5G to 5I Nov/Dec 2019, @ EPA screening limit soil residential 1200ppm eq to 1200mg/kg Source: https://www.atsdr.cdc.gov
5C Alwarthiru nagar, 5D MIOT Hospital, 5E Medavakkam junction, 5F Global Hospital, 5G Kalpana Hospital Adambakkam, 5H Madipakkam Koot Road, 5I Velakallu Bus Stop
.

4.2.2 Soil

67. The recent sandy soil (Entisols) is immature soils and is predominant in the city and it occurs in small patches. The major soil in this region belongs to Alfisols and Entisols. Inceptisols and Vertisols are found in a very limited area only. These soils are generally poor in soil nutrients. They have medium to high permeability. They have low water holding capacity except in patches of clayey soils.

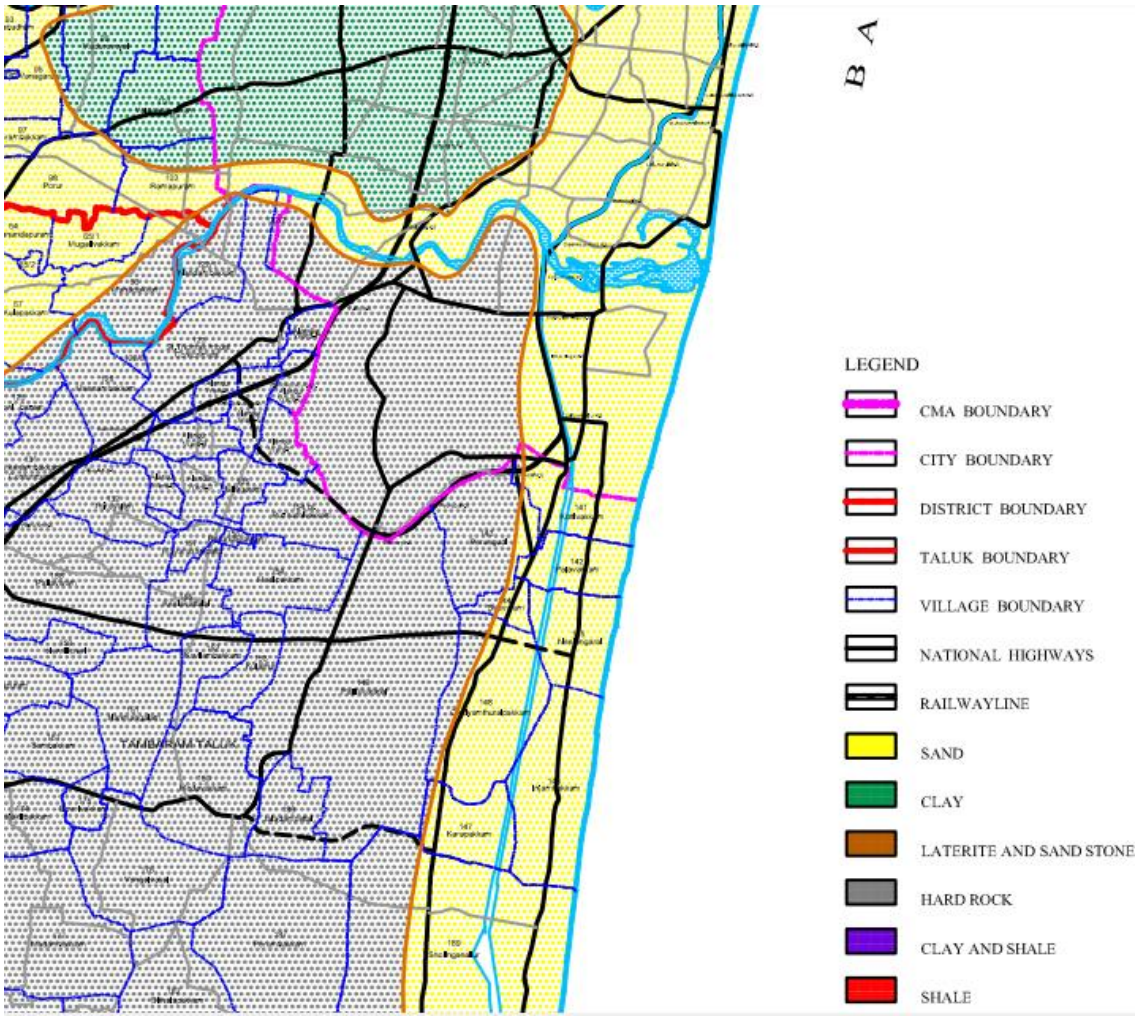
68. As per the predominant pattern shown up during the geotechnical investigation done in year 2016, hard rock is found at depth varying from 15 m to 20 m; sandy silty clayey soil upto depth 10.5 and weathered rock in the intervening range of depth. Ground water is found at depth upto 3 m.

69. The laboratory analysis results for soil are reported in Table 4.3. The soils are slightly alkaline in nature. Organic matter content in soils varies from 0.57% to 1.26%. The soil types found along the alignments, as recorded in the Master Plan 2026 for CMA are presented in Table 4.4 and Figure 4.3, subject to more specific findings from geotechnical investigations.

Table 4.4: Soil Types along alignment

Section	Type of soil
CMBT to Alapakkam	Clayey
Alapakkam to Porur to DLF IT SEZ	Sandy
DLF IT SEZ to Ok. Tho	Hard Rock

Figure 4.3: Soil Types in CMA



Second Master Plan for Chennai Metropolitan Area 2026, CMDA

4.2.3 Geology and Minerals

70. The geological formations in the region are from the Archaeans to the recent Alluvium (Table 4.5). The geological formations can be grouped into three units, namely (i) the Archaean crystalline rocks, (ii) consolidated Gondwana with Tertiary sediments and (iii) the recent Alluvium. Most of the geological formations are concealed by the alluvial materials, except for a few exposures of crystalline rocks like charnockites along the railway track in Guindy area. The thickness of Gondwana shales is highly variable in the city.

Table 4.5 Geological Formation in the Project Area

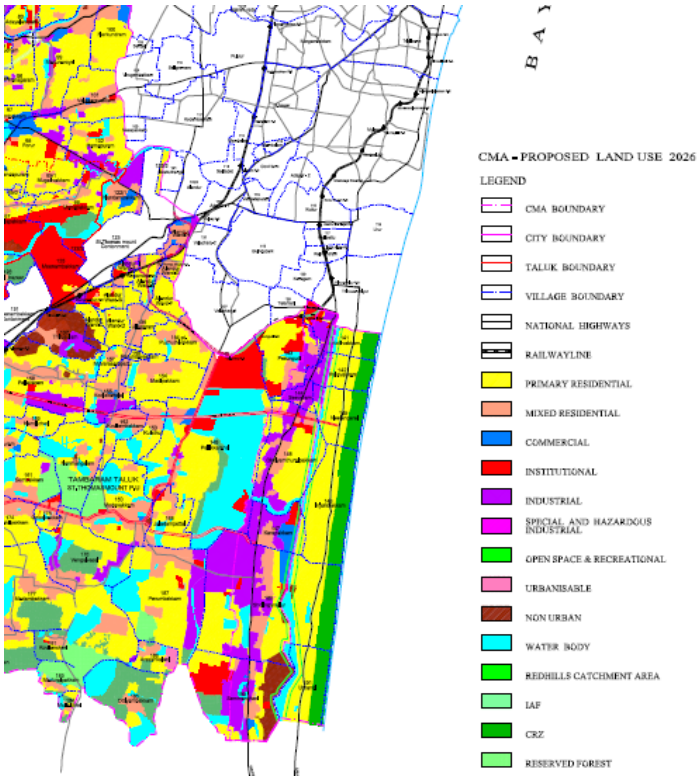
Geological succession in Chennai district Group	System	Age	Lithology	Aquifer Characteristics
Quarternary	Recent	Sub-Recent	Soils, Alluvium (sand & silt)	Moderate to good porous aquifer system
Tertiary	(Cuddalore Sandstone equivalents)	Eocene to Piliocene	Sandstone & and shale (fossiliferous)	Moderately Porous Aquifer
---UNCONFIRMITY---				
Mesozic	Upper Gondwana (Sri Perumbudur Beds)	Lower Cretaceous to Lower Jurassic	Brown Sandstone and siltstone; Grey shale; Black shale	Less Porous aquifer with minor fractures
---UNCONFIRMITY---				
Azoic	Archaean	--	Charnockites, Granites, Gneisses	Fractured Aquifer

Source: cpheeo.nic.in

4.2.4 Land Use

71. Landuse along the alignment of Balance C5 is predominantly mixed residential except industrial at Alapakkam, and commercial at CMBT, from Mugalivakkam to Sathya Nagar (2km) and from Perumbakkam to Ok. Tho (3.5km). Land use in year 2006 is depicted in Figure 4.4 and classified in Table 4.6.

Figure 4.4: Land Use in Chennai Metropolitan Area 2006



Source: Second Master Plan for Chennai Metropolitan Area, 2026

Table 4.6: Land use in CMA

	Land use 2006		Land use 2026	
	Area (ha)*			
Land use	**Chennai City**	**Rest of CMA**	**Chennai City**	**Rest of CMA**
Residential	9523	22877	8342	45593
Commercial	1245	390	714	880
Industrial	908	6563	822	10690
Institutional	3243	3144	2868	3888
Open Space and Recreational	366	200	1000	392
Agricultural	99	12470	Nil	7295
Non-urban	82	2433	113	2333
Others	2087	56507	3754	28147
Urbanisable	Nil	Nil	Nil	2075
Total	17553	104584	17613	101293

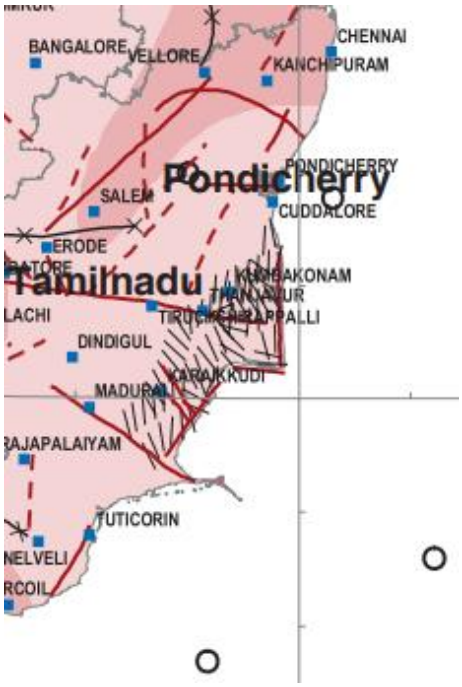
** Rounded off*

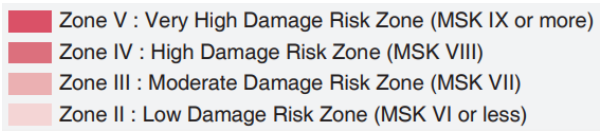
Source: Second Master Plan for Chennai Metropolitan Area, 2026

4.2.5 Seismicity

72. As per seismic zoning map of India shown at Figure 4.5, Tamil Nadu and Chennai are located in Moderate Seismic Zone (Zone III–BIS: 1893 (2001)).

Figure 4.5 Earthquake Hazard Map





Source: Vulnerability Atlas, 2nd edition, BMTPC

73. Last reported tremor in Chennai was on 12 February 2019 due to earthquake measuring 5.1 Richter (Source: IMD) with epicenter 10 km deep in Bay of Bengal.

4.2.6 Meteorology

4.2.6.1 Temperature

74. Chennai has a tropical wet and dry climate. The city lies on the thermal equator and is also on the coast, which prevents extreme variation in seasonal temperature. Meteorological data like monthly total rainfall, maximum & minimum temperature, wind rose and relative humidity of the Chennai for a period of Jan 2011 to Dec 2017 collected from IMD. Table 4.7 and Table 4.8 depict that the hottest part of the year is in the month of May with maximum temperature varies 41.0°C to 43.0°C. The coolest part of the year is January, with minimum temperature varies 17.7°C to 20.3°C.

Table 4.7 Monthly Highest Maximum Temperature (Deg C)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2011	31.1	32.6	37.7	35.7	41.7	38.6	38.0	36.9	36.4	35.4	32.6	31.6
2012	31.2	33.6	36.3	35.6	42.5	42.4	38.8	37.3	36.8	36.0	33.6	31.0
2013	30.9	32.5	35.1	37.4	42.7	39.7	38.3	36.9	35.7	35.6	33.6	32.1
2014	30.6	32.3	36.6	38.6	42.8	41.8	39.2	38.5	36.7	36.2	32.5	31.8
2015	31.3	33.1	35.1	36.8	42.2	39.6	41.0	37.6	36.9	35.7	32.6	32.4
2016	33.0	34.0	39.0	41.0	41.0	39.0	37.0	38.0	37.0	37.0	34.0	31.0
2017	31.0	36.0	36.0	41.0	43.0	41.0	39.0	37.0	36.0	36.0	34.0	33

Source: Regional Meteorological Centre, Chennai

Table 4.8 Monthly Lowest Minimum Temperature (Deg C)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2011	18.7	17.7	20.1	23.5	23.1	22.7	23.1	20.5	21.6	22.6	18.7	19.0
2012	17.7	19.2	22.4	25.7	27.1	24.2	22.6	23.7	22.0	22.2	17.6	20.7
2013	19.0	19.5	20.4	25.3	24.8	24.7	23.2	23.6	23.0	23.8	22.0	19.1
2014	20.3	19.0	22.1	25.6	24.3	23.0	23.6	22.9	23.7	23.4	21.3	21.0
2015	19.0	20.8	23.2	23.5	25.6	24.6	23.9	23.1	23.5	24.3	22.4	21.5
2016	19.0	20.0	23.0	25.0	25.0	24.0	24.0	24.0	23.0	22.0	19.0	19.0
2017	19.0	19.0	22.0	26.0	27.0	25.0	24.0	24.0	24.0	23.0	23.0	21

Source: Regional Meteorological Centre, Chennai

4.2.6.2 Rainfall

75. The city gets most of its seasonal rainfall from the North–East monsoon, from October to December. South-West monsoon prevails from June to September. Cyclones in the Bay of Bengal sometimes traverse through the city. The highest annual rainfall recorded is 1,049.3mm in November 2015 during an extreme weather event, the highest

since November 1918 when 1,088 mm of rainfall was recorded. The monthly rainfall is given in Table 4.9.

Table 4.9: Monthly Rainfall (mm)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2011	10.8	88.9	0.0	18.5	12.6	130.2	67.4	368.9	286.2	260	457.2	134.8
2012	16.3	0.0	1.6	0.2	0.0	24.7	79.9	89.5	214.1	422.6	47.0	125.5
2013	Trace	14.3	11.9	3.6	3.6	34.0	146.6	195.1	240.1	157.2	193.7	85.9
2014	0.1	9.9	0.0	0.0	13.5	96.2	69.7	222.6	130.8	405.5	196.9	149.9
2015	2.8	0.0	0.0	12.3	7.9	20.3	205.9	106.5	75.0	159.9	1,049.3	454.7
2017*	0.0	5.0	2.5	0.0	0.5	60.0	55.0	90.0	65.0	160.0	155.0	9.0

*Source: Regional Meteorological Centre, Chennai, * www.meteoblue.com*

4.2.6.3 Humidity

76. Mean Relative Humidity is presented in Table 4.10 and Table 4.11. It varies 56% to 88% at 08:30 hrs and 57% to 81% at 17:30 hrs. 2016 and 2017 data were collected at different time slots.

Table 4.10: Monthly Mean Relative Humidity at 08:30 hrs (%)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2011	82	81	77	75	64	60	70	79	80	84	85	88
2012	83	77	76	72	65	56	68	73	76	83	80	84
2013	88	84	80	77	73	61	80	83	82	86	86	80
2014	78	79	72	72	67	64	70	78	77	82	82	83
2015	83	81	74	72	69	66	70	77	77	83	91	86
2016*	94	100	94	94	100	100	100	100	100	94	100	100
2017*	100	94	94	94	89	100	100	100	100	100	100	100

*Source: Regional Meteorological Centre, Chennai, * at 05.30 hrs (www.timeanddate.com)*

Table 4.11: Monthly Mean Relative Humidity at 17:30 hrs (%)

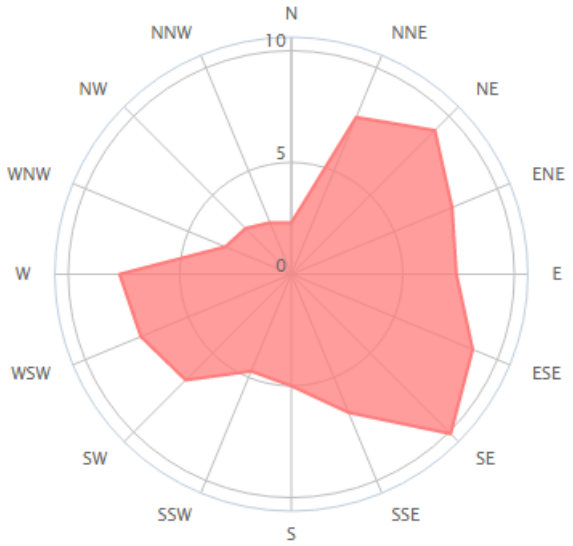
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2011	60	61	59	67	65	58	57	69	74	80	76	67
2012	68	61	68	70	65	59	61	70	73	77	73	78
2013	75	72	69	77	74	60	76	76	78	81	81	73
2014	69	67	64	68	68	66	65	74	75	80	77	76
2015	73	71	67	69	69	65	70	71	75	78	87	78
2016*	38	30	29	30	30	37	37	33	37	30	27	27
2017*	35	24	38	23	25	16	33	42	47	36	43	40

*Source: Regional Meteorological Centre, Chennai, *at 14.30 hrs (www.timeanddate.com)*

4.2.6.4 Wind

77. The wind rose diagram has been prepared based on the daily data for the period of 10/2009 to 08/2016. The prominent direction is NE, ESE and SE. Wind rose diagram for the Chennai is shown in Figure 4.6.

Figure 4.6: Wind Rose for Chennai



4.3 Ambient Environment

78. In order to assess the impact on existing ambient environment due to Balance C5 implementation, it is necessary to have baseline status of ambient environmental parameters.

4.3.1 Water Resources

79. As the city lacks a perennial water source, catering the water requirements of the population has remained an arduous task. Ground water levels from 2013 to 2016 were up to 10m below ground in pre-monsoon as well as post-monsoon seasons and rise in water level of up to 4m in 80% to 90% of observation wells in Chennai district between pre-monsoon and post-monsoon months. From May 2016 and January 2017, the ground water levels were up to 4m in 46% of observation wells (Groundwater Yearbook of Tamil Nadu and UT Puducherry, 2016-2017, Central Groundwater Board).

80. As per data provided by Chennai water authority, in 2017, the combined water level in the four reservoirs namely Red Hills, Cholavaram, Chembarambakkam and Poondi lakes was 4,365 mcft or 330 MLD. In May 2019 the combined storage level of these reservoirs was about 160 mcft or 8 MLD. On 19 June 2019, Chennai city officials declared that "Day Zero", or the day when almost no water is left, had been reached, as all the four main reservoirs supplying water to the city had run dry. Two years of deficient monsoon rainfall, particularly in late 2017 and throughout much of 2018 had led to this crisis (India Today 20 June 2019). Chembarambakkam lake is the nearest to the corridor at distance of 12 km to 15 km.

81. Chennai receives about 985 MLD from various sources against the required amount of 1,200 MLD. As of year 2018, 300 million litres of water was estimated to have been be sourced from the four reservoirs in Chennai with their storage standing at 40% of their capacity; 180 MLD from the desalination plants in Minjur and Nemmeli and 70 MLD (against the usual 180 MLD) from Veeranam tank. Krishna water of about 400 MLD supplements these sources; and other water sources, including abandoned stone quarries, agriculture wells and Neyveli Corporation mines. (Down to Earth 22 May 2019).

4.3.2 Drainage

82. Adyar River originates at the confluence (Thiruneermalai) of two streams that drains the upstream area of Chembarambakkam tank. It is a small river of 42 km length and a catchment of 800 Sq. km. The river carries flow all through 365 days of a year with an average discharge of 89.43 MCM/Year at Kathipara cause way. It drains the southern part of the district and remains flooded during monsoon. During the high tides, the backwater from the Bay of Bengal enters inland up to 3 to 4 km.

83. Cooum is the other main river flowing through the central part of the district and carries only drainage water, which is highly polluted. It originates from the surplus waters from the Cooum tank in Tiruvallore taluk and the tanks, which are in enroute, discharge their surplus water into the river during flood season. The flow of Cooum River at Korattur is 40.2 MCM/year for an average duration of 31 days in a year.

84. Otteri Nulla is another small stream flowing in the northern part of the city. Buckingham canal is the man made one for navigation purposes earlier, but now it act as sewerage carrier in the city.

4.3.3 Water Quality

85. Water sample has been tested at seven locations namely (i) Alwar Thiru Nagar junction (ii) MIOT Hospital (iii) Medavakkam Junction (iv) Global Hospital (v) Kalpana Hospital, Adambakkam MRTS (vi) Madipakkam Koot Road and (vii) Velakallu Bus Stop.

86. Considering the construction of piers in Adyar River and Adambakkam Lake, the water samples in the two waterbodies were collected and analyzed in October 2020 (Annexure 7-1). The level of COD showed a high level of industrial contamination in Adampakkam Lake.

87. Laboratory analysis depicts that the parameters in groundwater samples are well within the prescribed permissible limits for drinking water as per IS 10500-2012 except turbidity, manganese and mercury at Alwar Thiru Nagar, chloride, nitrogen and coliforms at Porur junction, hardness at MIOT Hospital, Medavakam and Kalpana Hospital Adambakkam, calcium at MIOT Hospital and Medavakkam, aluminium at kalpana Hospital Adambakkam, Madipakkam Koot Road, Velakallu bus stop, mercury at MIOT Hospital, chloride at Alwar Thiru Nagar, MIOT hospital and Medavakkam junction, total nitrogen and coliforms at all locations.

88. The measured values of TDS, TSS and BOD at Global Hospital (surface water) were found to violate General Quality Standards of Schedule VI Environment Protection Rules (EPR) 1986 for discharge of pollutant effluents in surface water: these standards are applicable for industries, operations or processes other than those industries, operations or process for which standards have been specified (104 industries) in Schedule I of EPR.

Table 4.12 Results of Laboratory Analysis of Water Sample

SN	Parameter	Unit	5C	5D	5E	5F *	5G	5H	5I	Acceptable/Permissible Limit for drinking water IS 10500 mg/l	Effluent standards – inland surface water EPR 1986 max. mg/l	Wildlife & fisheries - surface water CPCB 1978 Primary criteria mg/l	Drinking water - CPCB 1978 Primary criteria mg/l
1	pH at 25^{O}C	-	7.13	7.82	7.99	8.15	6.97	7.21	7.61	6.5-8.5/ no relaxation	5.5 to 9.0	6.5 to 8.5	6.5 to 8.5
2	Turbidity	NTU	67.3	<0.1	<0.1	76.5	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)	1/5 max	-	-	-
3	*Total Dissolved Solids*	mg/l	*1826*	*1528*	*1256*	*4386*	921	225	179	500/2000 max	-	-	-
4	Aluminium as Al	mg/l	BDL	BDL	BDL	0.054	**7.1**	**7.1**	**7.6**	0.03/0.2 max	-	-	-
5	Free Amonia (as NH3)	mg/l	<1	<1	<1	>0.5	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	-	Total ammonia 0.5 / no relaxation	5.0	1.2 or less
6	Barium (as Ba)	mg/l	0.13	0.146	0.046	0.23	BDL(DL:1.0)	BDL(DL:1.0)	BDL(DL:1.0)	0.7 max/ no relaxation	-	-	-
7	Boron (as B)	mg/l	0.004	BDL	0.04	BDL	4.6	BDL(DL:2.0)	BDL(DL:2.0)	0.5/1	-	-	-
8	Calcium as Ca	mg/l	82.6	210.5	206.4	123.8	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	75/200	-	-	-
9	*Chloride as Cl*	mg/l	*670.1*	*310.4*	*280.9*	*1995.7*	0.08	BDL(DL:0.01)	BDL(DL:0.01)	4.0/no relaxation	-	-	-
10	Copper as Cu	mg/l	BDL	BDL	BDL	BDL	109	24.2	44.4	0.3/no relaxation	3	-	-
11	Fluoride as F	mg/l	>1	>1	>1	>1	147	43.5	14.5	1.0/1,5	2	-	-
12	Iron as Fe	mg/l	0.15	BDL	BDL	0.14	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	0.3/ 1.0	3	-	-

13	Magnesium (as Mg)	mg/l	52.7	32.6	27.6	188.1	0.46	0.68	0.72	30/100	-	-	-
14	Manganese as Mn	mg/l	0.54	0.02	BDL	0.21	0.38	0.11	0.13	0.1/0.3	2	-	-
15	Nitrate as NO3	mg/l	BDL	9.5	17.2	1.1	32	10.3	11.3	45/ no relaxation	-	-	-
16	Phenolic Compounds	mg/l	BDL	BDL	BDL	BDL	BDL(DL:0.01)	0.03	BDL(DL:0.01)	0.001/0.002			
17	Selenium (as Se)	mg/l	BDL	BDL	BDL	BDL	32	BDL(DL:1.0)	BDL(DL:1.0)	0.1/ no relaxation	0.05	-	-
18	Silver (as Ag)	mg/l	BDL	BDL	BDL	BDL	47	BDL(DL:1.0)	BDL(DL:1.0)	0.1/ no relaxation	-	-	-
19	Sulphate as SO4	mg/l	46.1	158.2	11.7	155.6	BDL(DL:5.0)	BDL(DL:5.0)	BDL(DL:5.0)	200/400	-	-	-
20	Sulphide (as S)	mg/l	BDL	BDL	BDL	BDL	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	0.05/ no relaxation	2.0	-	-
21	Total Alkalinity as CaCO3	mg/l	*460.6*	*411.6*	*382.2*	*225.4*	BDL(DL:2.0)	BDL(DL:2.0)	BDL(DL:2.0)	200/600	-	-	-
22	Total Hardness as CaCO3	mg/l	*422.3*	*659.2*	*628.3*	*1081.5*	BDL(DL:4.0)	BDL(DL:4.0)	BDL(DL:4.0)	200/600	-	-	-
23	Zinc as Zn	mg/l	BDL	0.032	BDL	BDL	0.21	0.05	0.06	5/15	5	-	-
24	Cadmium (as Cd)	mg/l	BDL	BDL	BDL	BDL	0.21	BDL(DL:0.01)	BDL(DL:0.01)	0.003/ no relaxation	2.0	-	-
25	Cyanide (as CN)	mg/l	BDL	BDL	BDL	BDL	0.14	18	19	0.05/ no relaxation	0.2	-	-
26	Lead as Pb	mg/l	BDL	BDL	BDL	0.009	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	0.01/ no relaxation	0.1	-	-
27	Mercury (as Hg)	mg/l	**0.006**	**0.006**	0.0008	BDL	BDL(DL:0.002)	BDL(DL:0.002)	BDL(DL:0.002)	0.001/ no relaxation	0.1	-	-
28	Nickel	mg/l	BDL	BDL	0.002	0.004	BDL(DL:0.001)	BDL(DL:0.001)	BDL(DL:0.001)	0.02/ no relaxation	3.0	-	-
29	Total Arsenic as As	mg/l	BDL	BDL	BDL	0.003	2.7	42.3	10.1	0.01/0.05	0.2	-	-

30	Total Chromium (as Cr)	mg/l	BDL	BDL	BDL	BDL	BDL(DL:1.0)	BDL(DL:1.0)	BDL(DL:1.0)	0.05 max/no relaxation			
31	Total Suspended Solids	mg/l	21	5	3	184	BDL(DL:1.0)	BDL(DL:1.0)	BDL(DL:1.0)	-	100	-	-
32	Vanadium (as V)	mg/l	BDL	BDL	BDL	BDL	BDL(DL:1.0)	BDL(DL:1.0)	BDL(DL:1.0)	-	0.2	-	-
33	Ammonical Nitrogen (as N)	mg/l	<1	<0.1	<1	>0.5	3.9	2.1	1.9	-	-	-	-
34	Total Kjeldahl Nitrogen (as N)	mg/l	0.2	11.8	21.5	3.2	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	-	100	-	-
35	Chromium (as Hexavalent Chromium)	mg/l	BDL	BDL	BDL	BDL	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	0.05/no relaxation	-	-	-
36	Oil and Grease	mg/l	<1	<1	<1	1	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	-	10.0	-	-
37	Dissolved Oxygen		4.6	5.1	4.5	3.7	BDL(DL:0.001)	BDL(DL:0.0001)	BDL(DL:0.001)	-	-	4 or more	6 or more
38	Chemical Oxygen Demand	mg/l	64	36	60	220	BDL(DL:0.01)	BDL(DL:0.01)	BDL(DL:0.01)	-	250	-	-
39	Biochemical Oxygen Demand (3 day 27 deg C)	mg/l	23	11	23	75	0.62	0.42	0.36	200/600	30	-	2 or less
40	Total Phosphate as P	mg/l	0.9	0.3	1.1	0.27	0.38	0.11	0.14	-	-	-	-

41	Dissolved Phosphate (as P)	mg/l	0.9	0.3	1.1	0.27	BDL (DL:0.5)	BDL (DL:0.5)	BDL (DL:0.5)	-	5.0	-	-
42	Sodium as Na	mg/l	575	352.5	150	1010	BDL (DL:0.5)	BDL (DL:0.5)	BDL (DL:0.5)	-	-	-	-
43	Potassium as K	mg/l	15	3.4	6	30	402	103	157	-	-	-	-
44	Nitrate Nitrogen	mg/l	BDL	2.1	3.9	0.25	86	46	38	0.01/no relaxation	10.0	-	-
45	Total Nitrogen	mg/l	0.2	11.8	21.5	3.2	11.6	13.2	8.6	0.01/no relaxation	-	-	-
46	Organic Phosphorus	mg/l	BDL	BDL	BDL	BDL	268	92	72	5/15	5.0	-	-
47	Coliform Count	MPN /100 ml	<1	35	<1	54	8	2	2	Absent	-	-	-
48	Faecal Coliform	MPN /100 ml	<1	<1	<1	<1	23	17	22	Absent	-	-	-
49	Total Coliform Organism	MPN /100 ml	<1	12	<1	14	11	4	8	Absent	-		50 or les

4 locations 5C to 5F July 2016, 3 locations 5G to 5I Nov/Dec 2019 5F surface water sample; 5C Alwar Thiru Nagar, 5D MIOT Hospital, 5E Medavakkam junction, 5F Global Hospital, 5G Kalpana Hospital Adambakkam, 5H Madipakkam Koot Road, 5I Velakallu Bus Stop

4.3.4 Air Quality

89. The air pollutants emitted by point and non-point sources are transported, dispersed or concentrated by meteorological and topographical conditions. The monitoring results for ambient air quality are presented in Table 4.13. 24-hour air quality monitoring results indicates that Sulphur Dioxide (SO_2) and Nitrogen Dioxide (NO_2) were within the permissible level of National Ambient Air Quality Standards (NAAQS), SO_2 was within World Health Organization (WHO) guidelines. Particulate Matter was within NAAQS but exceeded WHO guideline at all locations. Concentration of Carbon Monoxide (CO) exceeded the permissible level of NAAQS but was within WHO guideline except at MIOT Hospital. The NAAQS laid down by CPCB and WHO guideline are given in Table 4.14.

Table 4.13 Ambient Air Quality

Parameter	Unit	5C	5D	5E	5F	5G	5H	5I
Sulphur Dioxide (SO_2)	µg/m^3	9.58	10.8	8.82	6.23	16.4	11.6	14.3
Nitrogen Dioxide (NO_2)	µg/m^3	13.60	15.38	9.35	9.48	27.9	23.8	26.1
Particulate matter (PM_{10})	µg/m^3	*84.12*	*73.34*	*69.97*	*62.37*	*69.5*	*60.7*	*59.5*
Particulate Matter ($PM_{2.5}$)	µg/m^3	41.67	33.96	25.14	29.16	31.8	33.4	29.8
Carbon Monoxide (CO)	mg/m^3	6	9	6	4	BDL	BDL	BDL

Table 4.14 National Ambient Air Quality Standards

Pollutant	Time weighted Average	Concentration in Ambient Air*		WHO Guideline
		Industrial, Residential, Rural &Other Area	Ecological Sensitive Area	
Sulphur Dioxide (SO_2) µg/m^3	Annual	50	20	-
	24 Hours	80	80	-
Oxides of Nitrogen (NO_2) µg/m^3	Annual	40	30	40
	24 Hours	80	80	-
Particulate Matter PM_{10} µg/m^3	Annual	60	60	20
	24 Hours	100	100	50
Particular Matter $PM_{2.5}$ µg/m^3	Annual	40	40	10
	24 Hours	60	60	25
Carbon Monoxide (CO) mg/ m^3	24 Hours	-	-	7
	8 Hours	02	02	10
	1 Hour	04	04	30

**Source: CPCB guidelines for AAQM*

4.3.5 Noise

90. The noise data was collected at 4 noise monitoring stations in year 2016. Later in 2019, monitoring of noise was conducted at 10 selected sensitive receptors which are located within 200 m on either side of the alignment (Annexure 1). The noise levels observed are listed in Table 4.15 and Table 4.16, locations are depicted in Figure 4.2 and Figure 4.7.

Figure 4.7: Locations of noise monitoring at sensitive receptors

10 locations 1C5 to 10C5; Field Survey: Dec 2019

Table 4.15 Ambient Noise Level dBA (by land use)

Location	Landuse	L_{10}	L_{50}	L_{90}	L_{max}	L_{min}	Leq_{day}	Leq_{night}
5C	Residential + Commercial	80.55	76.27	63.35	81.60	61.26	77.66	66.61
5D	Industrial	79.04	75.47	70.16	79.91	70.00	76.39	73.22
5E	Residential	72.59	67.78	58.70	73.79	56.49	69.37	60.91
5F	Residential	72.68	63.59	59.35	80.68	57.25	66.13	63.14

Field Survey: 5C to 5F July 2016

Table 4.16 Ambient Noise Level dBA (at sample sensitive receptors)

S.No	Name of the Sensitive Receptor	Locations on MDB Corridor 5	Type of Sensitive Receptor	Distance from the outer most proposed tracks (m)	Leq (Day) 50 dB(A)	Leq (Night) 40 dB(A)

1C5	Kalpana Hospital	Adambakkam MRTS – Medavakkam Main Road	Hospital	1.0	54.8	32.1
2C5	Anjanka Hospital	Madipakkam Koot road bus stop– Venkateshwara Nagar	Hospital	11.0	42.8	35.3
3C5	Sri Varasidhi Vinayakar Temple	Vellakallu Bus stop – Medavakkam Koot Road Bus stop	Temple	23.05	47.4	35.0
4C5	MM Hospital	Sai Nagar Bus stop – Elango Nagar Bus Stop	Hospital	29.76	49.7	37.3
5C5	St.Joseph College	CTC – St. Wesley Church	College	39.00	54.8	36.2
6C5	Ravindrabharathi Global School	Venkateshwara nagar – Echankadu Bus Stop	School	42.64	54.3	34.6
7C5	Govt. Boys School	Porur – Mugalivakkam	School	46.03	54.9	36.4
8C5	DMI St. Joseph Hospital	Porur – Mugalivakkam	Hospital	52.5	48.7	38.2
9C5	National Matriculation Hr. Sec School	St. Wesley Church - Alandur	School	56.0	51.4	38.7
10C5	Cantonment Board High School	CTC – St. Wesley Church	School	77.93	45.2	34.8

Field survey: Dec 2019

91. The Ambient Noise limits laid down by CPCB and WHO have been given in Table 4.17. The noise levels monitored at 4 locations in 2016 along the alignment were above the national and international permissible limits. Noise data was also monitored at 10 sensitive locations belonging to the silence zone, with 50% slightly exceeding GoI standards of 50dB the daytime limit (none per WHO guideline of 55dB), and none out of 10 exceeding 40 dB the night-time limit. The predominant source of ambient noise at monitored locations on is road traffic: all are located on urban arterials and regional highways.

Table 4.17 Ambient Noise Limits

Area Code	Category of Area	CPCB Limits dB (A) Leq		WHO Guideline **(LA eq dB)**	
		Day time*	Night time	Day time	Night time
A	Industrial area	75	70	70	
B	Commercial area	65	55	70	
C	Residential area	55	45	55	45
D	Silence Zone**	50	40		

*Source: CPCB guideline (as per The Noise Pollution (Regulation and Control) Rules, 2000) * CPCB day time is from 6.00 AM to 9.00 PM, WHO defines day time as 7.00 AM to 10 PM.; **Silence Zone is defined as an area up to 100m around premises of Hospitals, Educational Institutions, Courts of law and religious places or any others declared as such. Guidelines for Community Noise - WHO*

4.3.6 Vibration

92. Vibration consists of rapidly fluctuating motions of the particles without any net movement. Objects can vibrate differently in three mutually independent directions which are vertical, horizontal and lateral. It is common to describe vibration levels in terms of

velocity, which represents the instantaneous speed at a point on the object that is displaced. Vibrations are transmitted from the source to the ground and propagate through the ground to the receiver.

93. The triaxial transducers are placed at proposed survey location. The signals obtained from all three axes are in horizontal, transverse and vertical directions viz. X-Easting, Y-Northing and Z-Vertical direction. The standard measurable units for velocity are in mm/s. Measuring the peak particle velocity (PPV) is mostly used for representation of vibrating situation when the pressure wave passes through the particles. Soil conditions have a strong influence on the level of ground-borne vibration. The PPVs are usually expressed in terms of m/s or mm/s.

94. The dynamic analysis and seismic response have been studied for 8 locations including 6 identified sensitive receptors on Balance C5 comprising educational institutions and hospitals which are located near by the project as shown in Figure 4.8 and Figure 4.9.

Figure 4.8: Locations of vibration measurement by landuse

2 locations C5-B and C5-3; Field Survey: July 2019

Figure 4.9: Locations of vibration measurement at sample sensitive receptors

6 locations C5D to C5I ; Field Survey: Feb 2020

95. The induced ground vibration level is summarized in Table 4.20 and monitoring schedule is shown in Table 4.18. All the measurements are characterized on ground level i.e., pickup point is on ground level. Peak VdB vibration level at 6 out of 8 monitored locations is found to exceed acceptable criteria for ground borne vibration prescribed by the Federal Transit Administration (FTA) USA and Railway Design and Standards Organisation (RDSO) India which are more valid for operation of this project (Annexure 3). However the observed levels at all 8 locations are well below the construction vibration damage criteria for blasting as per Indian authorities Directorate General of Mines Safety (DGMS) and Central Institute of Mining and Fuel Research (CMFRI or CMRI) which are relevant only if blasting is undertaken during construction (Table 4.19).

Table 4.18: Vibration Monitoring Schedule

No	Location	Monitoring schedule	Duration (hrs)	Dates
Part 1				
C5-B	Valasaravakkam	12:26 PM - 12:42 PM	24	17/07/2019 to 18/07/2019

C5-3	Sholinganallur	11:46 AM - 11:55 AM	24	13/07/2019 to 14/07/2019
Part 2				
C5-D	Kalpana Hospital	10:16 AM -6:24 PM	08	21/02/2020
C5-E	MM Hospital	10:28 AM - 6:33 PM	08	20/02/2020
C5-F	St Joseph School	10:32 AM – 6:32 PM	08	17/02/2020
C5-G	Ravindra Bharathi Global School	10:24 AM - 6:34 PM	08	18/02/2020
C5-H	DMI St Joseph Hospital	10:33 AM - 6:39 PM	08	19/02/2020
C5-I	Cantonment Board High School	08:25 AM – 4:29 PM	08	22/02/2020

Table 4.19: Standards for Vibration

Type of structure	**Vibration (mm/s) for dominant excitation frequency, Hz**		
	< 8Hz	8-25Hz	>25Hz
DGMS			
(A) Buildings/structures not belonging to the owner			
Domestic houses/structures (kuccha, bricks & cement)	5	10	15
Industrial building	10	20	25
Objects of historical importance & sensitive Structures	2	5	10
(B) Buildings belonging to the owner with limited span of life			
Domestic houses/structures	10	15	20
Industrial buildings	15	25	50

After CMRI Standard (Dhar et al, 1993)

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

Source: DGMS (Tech) (S&T) Circular No. 7 of 1997

Table 4.20: Baseline Vibration

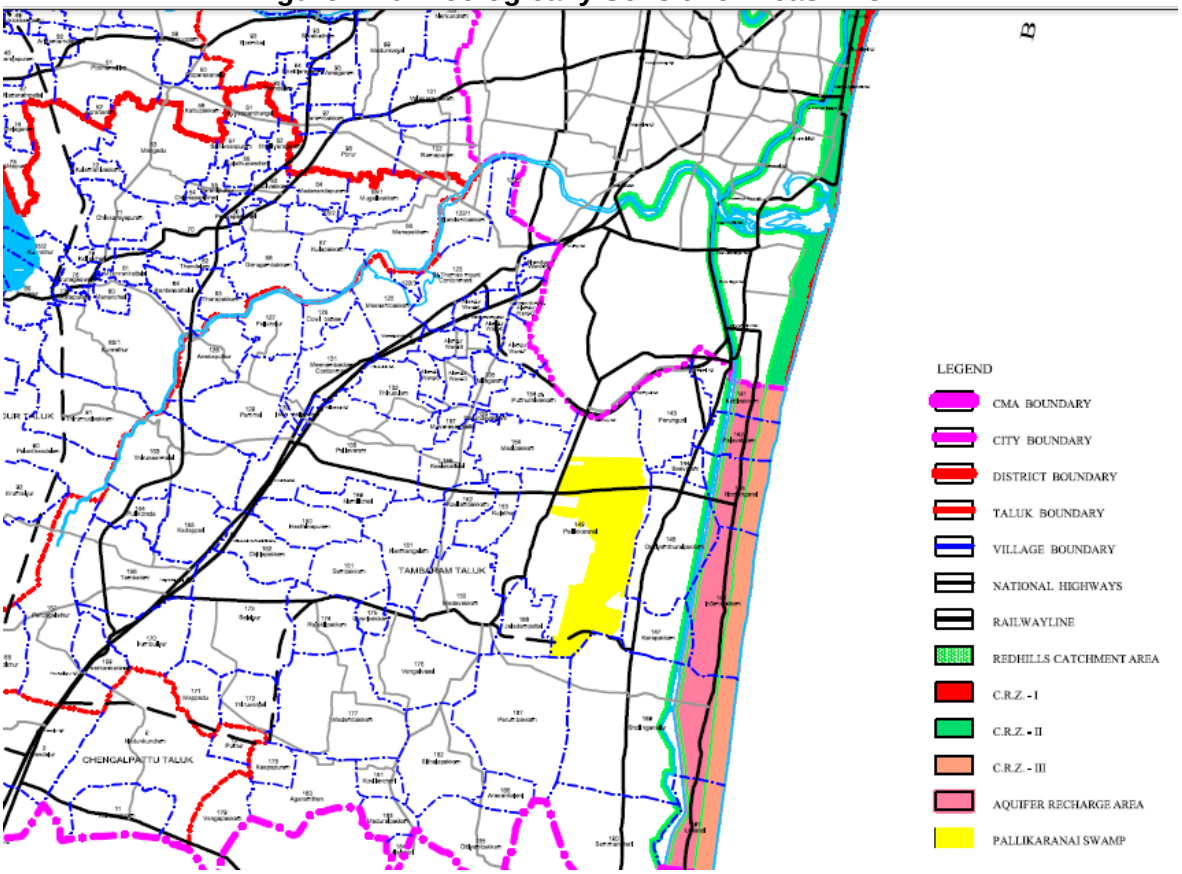
SN	Name of location	Surface Type	PPV (Maximum) mm/sec			VdB (Maximum)			VdB (Average)			VdB RMS		VdB acceptable
			East	North	Up	East	North	Up	East	North	Up	Max.	Time	
Part 1														
C5-B	Valasaravakkam	Soil	0.469	0.450	0.360	85.32	84.96	**83.02**	64.37	64.42	66.47	82.31 (East)	05.11 PM	72
C5-3	Sholinganallur		1.610	2.090	0.746	96.04	98.30	**89.35**	57.14	56.22	55.44	96.295 (North)	02.39 PM	75
Part 2														
C5-D	Kalpana Hospital	Tiles	0.117	0.101	0.136	73.27	71.99	74.57	67.47	68.27	69.08	71.56 (UP)	02:25 PM	65
C5-E	MM Hospital		0.145	0.114	0.239	75.13	73.04	79.47	67.07	67.94	72.03	76.46 (UP)	05:59 PM	65
C5-F	St Joseph School		0.063	0.108	0.240	67.86	72.57	79.51	62.00	65.79	70.35	76.50 (UP)	12:43 PM	75
C5-G	Ravindra Bharathi Global School		0.093	0.221	0.233	71.24	78.81	79.25	60.65	69.05	67.77	76.24 (UP)	12:08 PM	75
C5-H	DMI St Joseph Hospital		0.117	0.169	0.147	73.27	76.46	75.25	66.63	69.17	69.75	73.45 (North)	06:39 PM	65
C5-I	Cantonment Board High School		0.049	0.091	0.110	65.67	71.09	72.73	61.06	66.96	68.08	69.72 (UP)	03:18 PM	75

4.4 Ecological Environment

4.4.1 Ecologically Sensitive Areas in CMA

96. The ecologically sensitive areas in CMA are depicted in Figure 4.10. The following Table 4.21 lists the bird-watching areas in Chennai.

Figure 4.10: Ecologically Sensitive Areas in CMA



Source: Second Master Plan for Chennai Metropolitan Area, 2026

Table 4.21: Bird Watching Areas in Chennai

SN	Location
1	Indian Institute of Technology, Adyar – tropical dry evergreen forest with exotic plantation
2	Pallikaranai Marsh – Open water interspersed with reeds and bulrushes
3	Adyar Estuary/creek/Adyar Poonga – Estuary with Mudflats
4	Nanmangalam Forest Reserve – Scrub covered slopes and water covered pools
5	Guindy National Park – Tropical Dry Evergreen Forest
6	Vandalur Hills and Zoo – Undulating terrain with original scrub and planted trees
7	Crocodile Bank – Coastal setting with artificial ponds and tall planted trees being used as a heronry
8	Pallavaram Hills – Original scrub and some trees
9	Manali and Madhavaram Jheel – Lakes
10	Edayanchatram – Open scrub

11	Thiruneermalai, Pammal – Hillock with some scrub
12	Red Hills and Cholavaram – Lakes
13	Ennore Creek – Coastal vegetation
14	Chemmencheri tank – Waterbody
15	Chembarampakkam lake

Source: Madras Naturalists' Society

97. Balance C5 alignment is located about 2km from the Guindy National Park, however, the wildlife clearance is not required but project activities will strictly follow the guidelines issued by MoEF&CC regarding the prohibited, regulated and permitted activities (Table 4.22) and consultations with the TNFD. The alignment is approximately 1 km away from Nanmangalam lake which is home to a number of bird species; it also runs along existing road passing through Pallikaranai marshland which is also home to a wide variety of birds and other fauna. Diversion of 7,570 sqm scrub forest land will be required for the stretch traversing the Nanmangalam Reserve Forest. The alignment passing along Medavakkam main Road adjacent to Nanmangalam forest and along Perumbakkam main road through Pallikaranai marshland is depicted in Figure 4.11.

Figure 4.11 Balance C5 and Ecologically Sensitive Areas

RF Reserve Forest; BS Bird Sanctuary

98. Guindy National Park with an area of 2.70 sq km, which is under Reserve Forest category is classified as a Protected Area (ENVIS Centre of Wildlife and Protected Areas) and is located at distance of 2.6 km from the project alignment. In terms of density of vegetation cover, the area falls under sparse category.

99. The Guindy National Park is classified under tropical dry evergreen forests of the Coromandal coast and is being used for recreational purposes. The vegetation is mainly of the tropical dry evergreen type, and over 30 species of plants have been found including trees, shrubs, climbers, herbs and grasses. Chital and Blackbuck graze are found in the open grassland on the northern end of the park. Nocturnal animals include the toddy cat, civets, jungle cat, pangolin, and hedgehog. The dense forest, grasslands and water-bodies provide an ideal habitat for a large species of birds. Apart from snakes, certain species of tortoise and turtles, lizards, geckos, chameleons and the common Indian monitor lizard are also found here.

Table 4.22: Guidelines for Activities

Activity	Prohibited	Regulated	To be promoted
Discharge of effluents and solid waste in natural water bodies or terrestrial area	Yes	--	--
Felling of trees	---	Yes	---
Commercial use of natural water resources including ground water harvesting	---	Yes	---
Erection of electrical cables	---	Yes	---
Widening of roads	---	Yes	---
Movement of vehicular traffic at night	---	Yes	---
Air and vehicular pollution	---	Yes	---
Sign boards and hoardings	---	Yes	---
Underground cabling	---	---	Yes
Rain water harvesting	---	---	Yes
Renewable energy	---	---	Yes
Green technology for all activities	---	---	Yes

100. The Nanmangalam Reserve Forest is home to 100-125 species of birds in addition to 40 different species of butterflies and close to 20 species of damselflies and dragonflies. 442 different species of flowering plants are found inside the forest alone. The Reserve Forest's most famous inhabitant and star attraction is the great horned owl.

101. Pallikaranai Marsh is a freshwater swamp of 80 sq km, though the groundwater surrounding it with a high concentration of TDS indicates the sea water intrusion. It is one of the three wetlands in the state of Tamil Nadu which are included in wetlands identified under National Wetland Conservation and Management Programme. (MoEF&CC Annual report 2006-2007). Pallikaranai is reported with 125 species of birds, 10 mammals, 21 reptiles, 9 amphibians, 49 fishes, 9 molluscans and 7 butterflies and 120 plant species. It is home to some of the birds such as the Black-bellied Tern[1] (EN) and Great Knot

[1] This species is a long-distance migrant that largely travels along the coast making few stopovers (del Hoyo et al. 1996) but utilising different routes in the autumn and the spring (del Hoyo et al. 1996, Higgins and Davies

[2](EN). Pallikaranai known for diverse variety of visitors and resident bird species. It is also home to some of the reptiles such as the fan throated lizard (LC), Eastern Russell's Viper (LC) and King Cobra (VU). Other estuarine fauna present at the marsh includes the windowpane oyster (NA), mud crab (NA), mullet (DD), halfbeak (NA) and Green Chromide (LC). Plankton study shows that the water body is Eutrophic in nature. (Source: nammapallikarnai.org)

102. The focused biodiversity study is ongoing and upon finalization of the standalone Biodiversity Study Report with primary baseline information will be disclosed. As part of this Biodiversity Report, the Biodiversity Management Plan (BMP) will be prepared based on the approved Working Plan of TNFD.

4.4.2 Flora and Fauna

103. The number of trees on public land likely to be cut is 305. Their number on private land is to be ascertained from the field. No rare or endangered species of trees were noticed during field studies**.** The number of tree felling will be updated during the site clearance. The predominant tree species along the project corridors are listed below in Table 4.23.

Table 4.23: Predominant Tree Species along the Corridor

Species (Local name- Botanical name)	IUCN status
1. Vembu- *Azadirachta indica*	*LC*
2. Vadam- *Terminalia catapa*	*LC*
3. Nirkadambai - *Neonauclea purpurea*	*NE*
4. Thoongu moonji - *Albizia saman*	DD
5. Panei - *Borassus flabellifer*	*NE*
6. Pungam - *Pongamia pinnata*	*LC*
7. Mayir Konnai - *Delonix regia*	*LC*
8. Nettilingam- *Polyalthia longifolia*	*NE*
9.Vagai - *Albizia lebbeck*	*NE*
10.Thennai - *Cocos nucifera*	*NE*
11. Shevaga - *Morinda tinctoria*	DD
12. Nuna - *Bombax malabarica*	*NE*
13. Arasu - *Ficus religiosa*	*NE*
14.Al - *Ficus benghalensis*	*NE*
15. Ma - *Mangifera indica*	*DD*

LC Least Concern; NE Not evaluated; DD Data Deficient; - Not known

1996). It breeds from late-May to late-June, departing the breeding grounds in July and arriving on the wintering grounds between August and October (del Hoyo et al. 1996). The return migration to the breeding grounds takes place from March to April (del Hoyo et al.1996) although juvenile non-breeders often remain in the tropical parts of the wintering range for the breeding season (Hayman et al. 1986). The species forages in large flocks of one hundred to several thousand (del Hoyo et al.1996) at favoured sites on passage (Hayman et al. 1986), but during the winter it typically forages in small groups (Johnsgard 1981). A new global population was estimated at 292,000-295,000 individuals in 2007.

[2] This species is almost extinct in a large part of its range and is thought to be in very rapid decline overall, owing to a multitude of threatening processes that affect riverine species in southern Asia. It is therefore listed as Endangered. The population estimate is currently placed at 10,000-25,000 individuals, roughly equating to 6,700-17,000 mature individuals, until more data are available. It is found on large rivers (usually breeding on sandspits and islands) and marshes, occasionally on smaller pools and ditches, in lowlands (but not on the coast), up to 730 m.

104. To minimize tree cutting it is proposed to transplant young trees to the extent possible. Local forestry officials will be consulted to transplant the trees at suitable locations.

105. Other than the species found in Nanmangalam and Pallikaranai, common birds observed in the project area are pigeons, parrot, crows, and doves; predominant mammals are mongoose, bat, Squirrel, monkey and mice etc.

106. Necessary mitigation measure will be implemented to reduce the indirect impacts of Balance C5 on avifauna in Nanmangalam reserved forest and Pallikaranai marsh and overall ecology.

4.5 Socioeconomic Environment

4.5.1 Utilities

107. The entire length of Balance C5 is planned to be run through the urban area elevated. The alignment will cross drains, large number of sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, traffic signals and street lights. The utility information is attached in Annexure 4.

4.5.2 Physical Cultural Resources

108. No protected archaeological monuments/sites nor heritage assets are located on or along the proposed alignment, except the Madras War Cemetery near Guindy have to be included, which is maintained by Commonwealth War Graves Commission (CWGC).

109. Of 213 sensitive receptors which are located within 200m on either side of the alignment, 158 are of having religious and cultural values. The religious structure identified are listed in the Annexure 1.

4.5.3 Demographic Features

110. The Project will improve passenger transportation in Chennai Metropolitan Area which is projected to support resident population of 125.82 lakh in year 2026. As in year 2014, almost all households in the urban parts of the 3 districts contributing to CMA are supported by at least one employed person. In the project affected households, about 50% of are working on salary or daily wages or contract or job works, 40% are business owners; 17% of households are in vulnerable category comprising those below income poverty line (about 4%), socially weak communities and women headed households.

111. The other socioeconomic baseline is described in the standalone Social Impact Assessment.

5. ANTICIPATED IMPACTS AND MITIGATION MEASURES

112. The potential impacts and risks were analyzed in the confines of Balance C5 alignment's direct impact area, which is defined in this study as a strip of 15m, however, sensitive receptors located within 200m on either side of the alignment were identified. Influence area where most of the socio-economic and cumulative impacts will occur is defined as the entire confine of the area in Chennai city.

113. Alignment of Balance C5 passes contiguous to Nanmangalam reserve forest and along and near existing road passing through Pallikaranai marshland: both these areas are home to a large number of native and migratory birds and other fauna. 7,570 sqm forest land will be diverted to metro project near proposed metro station Medavakkam Koot Road Bus Stop. This will be permanent land use change from forest land to non-forest use.

114. The negative environmental impacts are:

- Impacts on the Nanmangalam reserve forest and Pallikaranai marsh land.
- Loss of about 305 trees for construction of Balance C5.
- Noise and vibration due to piling, excavation machines, and materials hauling.
- Safety risks, inconvenience of traffic nuisance and poor accessibility due to road closures and diversions, noisy conditions etc. will also be created due to plying of large number of heavy trucks transporting construction material, equipment and machinery in and around the project area.
- Increased noise and air pollution resulting from traffic volume due to construction.
- Increased local air pollution due to rock crushing, cutting and filling works
- Risks for damage to structures from vibration due to construction and operation.
- Risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological hazards due to project construction and operation.
- Dislocation or involuntary resettlement of people as there will be a need for land acquisition for the viaduct and stations.

5.1 Impacts Screening

115. Adverse and positive impacts that are likely to result from Corridor development have been listed in Table 5.1 under the following headings:

- Impacts and Mitigation Measures due to Project Location and Design;
- Impacts and Mitigation Measures due to Construction;
- Impacts and Mitigation Measures due to Project Operation

Table 5.1: Impacts Assessment Matrix

VEC/Sensitivity	Impact/Activity	Stage	Duration	Area	Severity	Significance before mitigation measures	Significance of Residual Impacts if any
1. Physical environment							
1.1 Air quality and GHG emissions (High sensitivity)	More efficient and environmentally friendly movement of people	D	Permanent	Local	High	Major +ve	High +ve
	Sourcing of construction material; Emissions from machinery and vehicles; site operations; operations in construction yard; dumping at excavate and waste disposal sites	C	Temporary	Local	Medium	Major	None
	Modal shift towards public transport	O	Permanent	Local	High	Major	High +ve
1.2 Surface water quality (High sensitivity)	Degradation of water quality due to sewage discharge	D	Permanent	Limited	Low	Moderate	Minimal -ve
	Run-off and waste water from construction sites, construction yards, waste disposal sites, labour camps	C	Temporary	Local	Low	Moderate	Minimal -ve
	Sanitation at stations	O	Permanent	Local	Low	Moderate	Minimal -ve
1.3 Surface water quantity (High sensitivity)	Use for stations	D	Permanent	Local	Low	Moderate	Moderate -ve
	Use of water for construction purposes	C	Temporary	Local	Medium	Moderate	None
	Increased water demand from public water supply	O	Permanent	Local	Medium	Moderate	Minimal –ve
1.4 Ground water quality (Medium sensitivity)	Degradation of groundwater quality	D	Permanent	Limited	Low	Minor	None
	Run-off and waste water from construction sites, construction yards, waste disposal sites, labour camps	C	Temporary	Local	Low	Minor	Minimal -ve

Table 5.1: Impacts Assessment Matrix

VEC/Sensitivity	Impact/Activity	Stage	Duration	Area	Severity	Significance before mitigation measures	Significance of Residual Impacts if any
	Degradation of water quality due to sewage discharge	O	Permanent	Limited	Low	Minor	Minimal -ve
1.5 Ground water quantity (High sensitivity)	Groundwater recharge due to rainwater harvesting	D	Permanent	local	High	Major +ve	High +ve
	Use of water for stations (groundwater extraction will be avoided)	D	Permanent	Limited	Medium	Neutral	None
	Dewatering activities	C	Temporary	Limited	Low	Moderate	None
	Water supply at stations (groundwater extraction will be avoided)	O	Temporary	Local	Low	Neutral	None
1.6 Land degradation/ pollution (Low sensitivity)	Location of construction yards and C&D waste (muck) disposal sites	D	Permanent	Limited	Medium	Minor	Moderate -ve
	Soil erosion due to site clearing and levelling; pollution due to operations at construction yards, C&D and hazardous waste disposal sites; drainage changes of excavate and C&D waste disposal sites	C	Temporary	Limited	Low	Minor	Minimal –ve Moderate -ve
	None as long as proper waste management procedures are followed	O				Neutral	None
2. Biological environment							
2.1 Trees, terrestrial and aquatic vegetation	Removal of trees	D	Permanent	Local	High	Moderate	Minimal -ve
	Damage to maintained trees and bushes	C	Temporary	Limited	Low	Minor	Minimal -ve

Table 5.1: Impacts Assessment Matrix

VEC/Sensitivity	Impact/Activity	Stage	Duration	Area	Severity	Significance before mitigation measures	Significance of Residual Impacts if any
(Medium sensitivity)	Siltation of water bodies						
	Growth of compensating trees	O	Permanent	Local	Low	Major +ve	Minimal -ve
2.2 Terrestrial fauna (mammals, birds, insects) (Low sensitivity)	Impact of height of viaduct and lighting on birds	D	Permanent	Local	Low	Moderate	Moderate –ve
	Impact of height of viaduct, noise and vibration, lighting on birds	C	Temporary	Local	Low	Moderate	None
		O	Permanent	Limited	Low	Moderate	Moderate –ve
2.3 Ecologically important areas (Medium sensitivity)	None	D				Neutral	None
	Extraction of sand from riverbeds. Banned.	C	Permanent	Local	Low	Neutral	None
	None	O				Neutral	None
3. Social environment (including those through environmental media)							
3.1 Private land and buildings (Medium sensitivity)	Transfer of private land	D	Permanent	Local	Medium	Major	High -ve
	Aesthetic impact. Limited reduction with proposed sleek structures	D	Permanent	Local	Medium	Major	High –ve
	Temporary use of land for construction, labor camps and traffic detours	C	Temporary	Limited	Medium	Moderate	None
	Aesthetic impact.	O	Permanent	Local	High	Major	High –ve
3.2 Public property/infrastructure/ utility structures (High sensitivity)	Diversions of utility services including water pipelines and high tension lines	D	Permanent	Local	Medium	Major	None
	Traffic diversions	C	Temporary	Local	High	Major	None
	None	O				Neutral	None
3.3 Noise (High sensitivity)	Metro noise adds to baseline noise which is already high. However, significant reduction with proposed design features.	D	Permanent	Limited	High	Major	Moderate -ve

Table 5.1: Impacts Assessment Matrix

VEC/Sensitivity	Impact/Activity	Stage	Duration	Area	Severity	Significance before mitigation measures	Significance of Residual Impacts if any
	Noise due to operation of construction equipment and vehicular movement	C	Temporary	Local	Medium	Major	None
	Noise due to metro operations	O	Permanent	Local	Medium	Major	Moderate -ve
3.4 Vibration (High sensitivity)	Metro vibration adds to baseline level which is already high. Limited reduction with proposed design features.	D	Permanent	Limited	Medium	Major	High –ve
	Vibration due to operation of construction equipment	C	Temporary	Local	Medium	Major	None except in cases of building damage
	Vibration due to metro operations	O	Permanent	Local	Medium	Major	High –ve
3.5 Occupational health and safety (Medium sensitivity)	Design of Health and Safety features in stations and trains for construction workers and operating staff	D	Permanent	Limited	Medium	Moderate	Construction, operation accidents, EMR: minimal –ve COVID-19 Moderate –ve
	Impacts due to labor camp, working on heights and with heavy machinery; Transmission risk of COVID-19	C	Temporary	Limited	Medium	Moderate	Works: None except in case of disabling injuries. COVID-19: Moderate –ve
	Electromagnetic interference (EMI) Exposure to electromagnetic radiation Accidents COVID-19 Musculo-skeletal disorders and stress	O	Permanent	Limited	Medium	Moderate	Minimal -ve Minimal –ve Minimal -ve Moderate -ve Moderate -ve

Table 5.1: Impacts Assessment Matrix

VEC/Sensitivity	Impact/Activity	Stage	Duration	Area	Severity	Significance before mitigation measures	Significance of Residual Impacts if any
3.6 Public health and safety (Medium sensitivity)	Safety risks due to flooding and earthquakes Transmission risk of COVID-19	D	Permanent	Limited	High	Major	Flooding High -ve Earthquake moderate -ve COVID-19 Moderate -ve
	Exposure to traffic, noise, dust and vibrations; Transmission risk of COVID-19	C	Temporary	Limited	Medium	Moderate	None Moderate -ve
	Electromagnetic interference (EMI) Exposure to electromagnetic radiation Incidents which disrupt services Transmission risk of COVID-19	O	Permanent	Local	Medium	Moderate	Minimal -ve Moderate -ve Minimal -ve Moderate -ve
3.7 Physical cultural resources (PCR) (Medium sensitivity)	Possible impact on religious or cultural buildings / structures within 200 meter of the alignment	D	Permanent	Limited	Medium	Minor	Minimal
	Chance finds	C	Short-lived	Limited	Low	Minor	Minimal
	None	O				Neutral	None
3.8 Energy (Medium Sensitivity)	Energy Demand for lighting and equipment	D	Permanent	Limited	Medium	Moderate	Minimal –ve
		C	Short-lived	Limited	Medium	Moderate	None
		O	Permanent	Limited	Medium	Moderate	Minimal -ve
3.8 Utilisation of metro (Medium Sensitivity)	The well designed alignment offers riding comfort, average speed and system capacity and thus the economical operation of the metro. The rational space planning of stations offers safety of	D	Permanent	Limited	High	Major +ve	High +ve

Table 5.1: Impacts Assessment Matrix

VEC/Sensitivity	Impact/Activity	Stage	Duration	Area	Severity	Significance before mitigation measures	Significance of Residual Impacts if any
	passengers, optimises time spent in ingress & egress from station and energy consumption. Modal integration will improve ridership.						

116. For each of these headings, potential impacts are evaluated and mitigating measures have been proposed.

5.2 Impacts and Mitigation Measures due to Project Location and Design

117. These impacts are:

- Change of Land use and Socio-economic impacts
- Loss of trees
- Impact on avifauna
- Impacts on Utilities
- Impact on physical cultural resources (PCRs)
- Climate Vulnerability
- Operational Noise and Vibration

5.2.1 Land Use and Socio-economic Impacts

118. Balance C5 project will require transfer of 3.564 ha government land and acquisition of 6.052 ha private land. 811 families will be affected 59 families will be displaced from residential structures and 116 from commercial structures; 162 and 474 families respectively will be partially affected. These figures will be revised upon completion of field socio-economic survey of affected families, revision of detailed drawings, preparation of land plan and micro plan of impacts. The land acquisition, resettlement and socio-economic impacts are assessed in the SIA report.

5.2.2 Tree cutting

119. The construction of Balance C5 will require cutting of about 305 public trees in total. None of trees to be cut are rare or endangered species. Amount of oxygen produced per tree per year for urban forests was adopted as 11 kg (Oxygen Production by Urban Trees in the United States, David J. Nowak, Robert Hoehn, and Daniel E. Crane, Arboriculture & Urban Forestry 2007). Per US Department of Agriculture and Maharashtr SPCB data, one mature tree can absorb approximately 22 kg (or 48 pounds) of CO_2 each year. With removal of these trees, the process for CO_2 conversion will get affected and the losses are reported below:

i. Total number of Trees : 305
ii. Decrease in CO_2 absorption due to loss of trees: 6,710 kg/year
iii. Decrease in Oxygen production due to tree loss: 3,355 kg/year

120. Location for compensatory plantation will be decided by CMRL in consultation with owner of the land as well TNFD such that displacement does not become necessary. The TNFD is responsible for the conservation and management of the trees. It is proposed to plant twelve saplings for each tree to be cut. Hence 3,660 trees shall be planted. The replantation plan including sites and species for compensatory plantation, and identification of trees to be transplanted will be prepared by CMRL in consultation with TNFD, CMDA and Municipal Corporation. The native plant species and miscellaneous indigenous tree species are recommended for plantation. Transplantation will be done in coordination with TNFD.

5.2.3 Impact on avifauna

121. Alignment of Balance C5 passes contiguous to Nanmangalam reserve forest and along and near existing road passing through Pallikaranai marshland: both areas are home to a large number of native and migratory birds and other fauna. The forest land to be diverted to the project is devoid of tree felling, hence no destruction to avifauna habitats due to tree felling will be expected. As mentioned in Table 3.2, the alignment is located 1 km away from Nanmangalam lake located in Nanmangalam forest.

122. Construction and operation of the metro viaduct on these sections could disturb nesting and breeding due to noise and vibration. Independently the elevated structure could impede flight of birds.

123. Effects of Artificial Light at Night on wildlife have been recorded: influences on nest site selection by sea turtles, changes in the diversity and behavior of nocturnal moths, and alterations to ecological interactions of insects. Trees in close proximity to sources of artificial lights budburst earlier than trees away from lights. More subtle effects of light pollution on birds are also known, such as disorientation, alterations in reproductive physiology, disruption of circadian rhythms, and changes of flight behavior (Light pollution is greatest within migration passage areas for nocturnally-migrating birds around the world, Sergio A. Cabrera-Cruz etal, Scientific Reports volume 8, Nature).

5.2.4 Impacts on Utilities

124. Balance C5 is planned to run through the urban area elevated. The alignment will cross drains, large number of sub-surface, surface and utility services, viz. sewer, water mains, storm water drains, telephone cables, overhead electrical transmission lines, traffic signals, roadside lights etc. The Organizations / Departments responsible for concerned utility services are reported in Table 5.2.

Table 5.2: Organizations Responsible for Utilities

SN	Organization/ Department	Utility/Services
1.	Tamil Nadu Public Works Department	Roads and bridges other than National Highways
2.	Chennai Municipal Corporation	City roads and bridges , including hydrants and fountains etc., Roads, surface water drains, nallahs, sewer lines, streetlights
3.	Chennai Metropolitan Water Supply & Sewerage Board	Water and sewage treatment plants, pumping stations sewerage and drainage lines; water mains and their service lines
4.	National Highway Authority of India	Roads and bridges on National Highways
5.	Indian Railways	Railway crossings, subways, signals, bridges, stations etc.
6.	BSNL (OFC and Telephone Cables)	Tele cables, junction boxes, telephone posts, O.H lines

7.	Airtel, Vodafone, Idea, Jio, RailTel	Telecommunications cables, junction boxes, telephone posts, etc.
8.	Power Grid Corporation of India Ltd.	HT towers, cables
9.	Irrigation Dept.	Canal
10.	IOCL, BPCL	Petroleum pipelines
11.	Gas Authority of India (GAIL)	Gas pipelines
12.	Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO)	HT/other overhead Power lines

125. These utility services are essential and have to be maintained in working order during different stages of construction, by temporary/permanent diversions and relocation or by supporting in position. Any interruption to these will have serious repercussions on the most sensitive suburban services and direct impact on the public besides set back in construction and project implementation schedule & costs. They may require temporary or permanent diversion subject to their depth, details such as piling configuration or span of viaduct, utility protection measures, etc.

126. During construction the most important and hazardous aspect will be pipelines network running along the alignment. A decision has to be taken regarding encasing these pipelines as shifting/relocating will be of great inconvenience to the residential areas. In case detailed pre-construction utility survey by Contractor identifies gas pipelines, HAZOP study (& risk analysis) will be conducted by contractor and CMRL during pre-construction period for any kind of handling of this issue in concurrence with gas supply agency. The similar study has to be conducted for water supply and high tension lines with the concurrence with concerned agencies.

127. In case public utilities are required to be shifted to private land in exceptional circumstances, then adequate compensation shall be made by CMRL to the property owner on the same principles as temporary land acquisition. Following completion of construction of metro, such utilities shall be rehabilitated on public land.

128. Ground survey to confirm location of pipelines and other utilities will be done by Contractor after which detailed design consultant will revise, where feasible, spans and pile arrangement. Where the alignment cannot be fine-tuned to avoid conflict with utilities, permanent diversions will be done section wise before commencement of construction of viaduct work on the pertinent section; temporary diversions can be done before or during construction. Plans for diversion or relocation of any utilities along with hazard studies if required will be prepared by the Contractor in consultation with and approval of respective utility agencies before finalisation of time schedule of metro construction works. Preferably they will have to be diverted by the agencies themselves. Any HAZOP investigation and utility diversion will be done 3 months before start of construction of viaduct (scheduled start of viaduct works is July 2021).

5.2.5 Impacts on Physical Cultural Resources

129. No protected archaeological monuments / sites or heritage assets are located on the project corridor, except the Madras War Cemetery near Guindy have to be included,

which is maintained by Commonwealth War Graves Commission (CWGC). Of 213 sensitive receptors which are located within 200m on either side of the alignment, 158 are of having religious and cultural values.

130. Since the project involves piling for piers there are possibilities that contractor may encounter artefacts during piling operation. Chance find measures are included in the EMP to minimize the impacts on historical / archeological artifacts, in case found during excavation work. CMRL will inform and coordinate with Archaeological Survey of India if any ancient remains are encountered during construction work.

131. At pre-identified culturally valuable sites if any near the alignment, or finds in the project's direct area of impact the contractor shall prepare a monitoring scheme prior to construction at such locations. This scheme for monitoring vibration level shall be submitted to CMRL for approval. The scheme shall include:

- Monitoring requirements for vibrations at regular intervals throughout the construction period.
- Pre-construction structural integrity inspections of pre-identified culturally valuable structures
- Information dissemination about the construction method, probable effects, quality control measures, and precautions to be used.

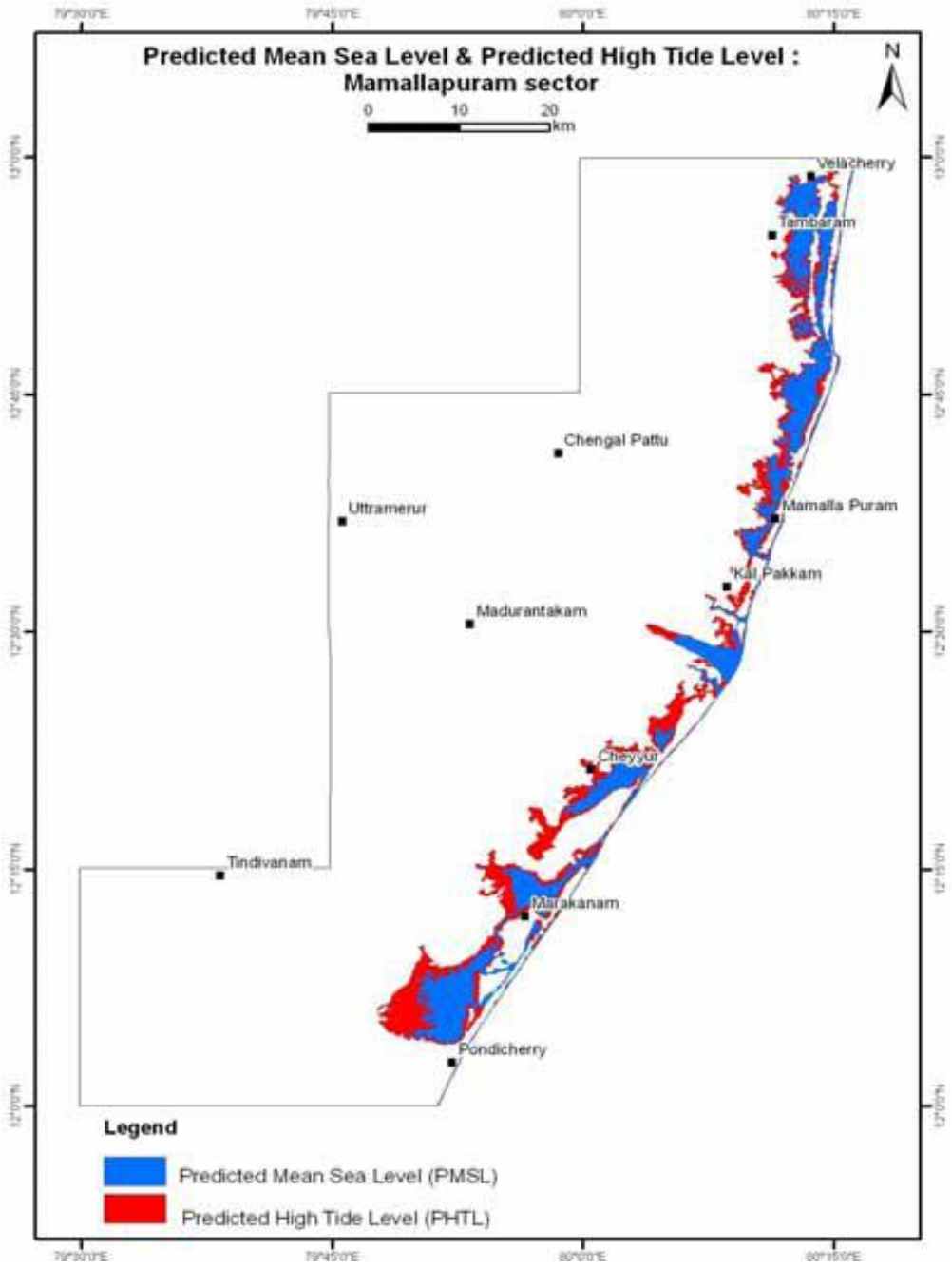
132. The vibration level limits at work sites adjacent to the alignment shall conform to the permitted values of PPV.

5.2.6 Climate Vulnerability

5.2.6.1 Sea level rise due to climate change

133. Vulnerability of project to rise in mean sea level (submergence) and high tide level (degradation) on the project is indicated in Figure 5.1. Length of elevated corridor 5 from Medavakkam to Ok. Tho may be submerged/degraded: passenger access can be cut off rendering the line unusable, rising tide level could also degrade Metro structures by way of increased corrosion.

Figure 5.1 Predicted MSL and HTL
(alignment indicated in black in inset)



Source: Coastal Zones of India, SAC ISRO- MoEF&CC, 2012

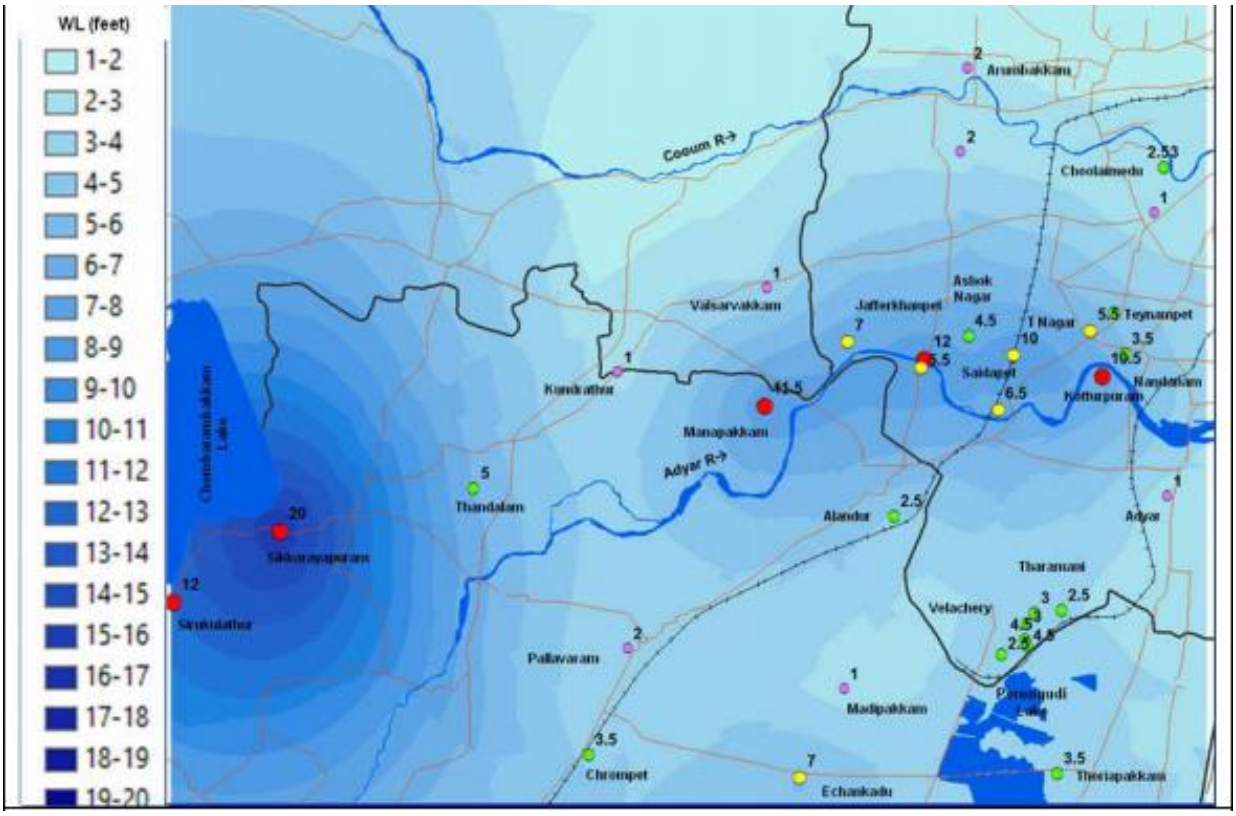
5.2.6.2 Flooding resulting from Anomalous Heavy Rainfall

134. In year 2015 Chennai was flooded due to exceptionally heavy rainfall. Flooding was observed in areas adjoining Adyar river though lesser along Cooum river. The alignment of Corridor 5 is not located near these rivers[1] and therefore flooding is not a likely impact.

[1] Proposed Alandur station which had up to 2.5 feet of water during the 2015 floods according to figure 5.2 is about 2500 meters away from NH45 bridge on Adyar River which saw water level of 12 feet; proposed Echangadu station which had 7 feet of water is located at 2600 meters from Pallikaranai marsh.

Moreover Pallikaranai marsh could store excess water thus reducing flooding. Figure 5.2 depicts the inundated areas.

Figure 5.2: Chennai Flood map 2015



Source: Chennai Floods, 2015 A Satellite and Field Based Assessment Study, Disaster Management Support (DMS) Division National Remote Sensing Centre (NRSC / ISRO) Hyderabad, India

5.2.6.3 Risk Due to Earthquake

135. Chennai is located in Moderate Seismic Zone. Design of viaduct and elevated stations shall be done to facilitate robust safety and quicker evacuation.

5.2.7 Operational Noise and Vibration

136. As part of the detailed design a noise and vibration modeling and assessment along the alignment should be conducted prior to start of construction by CMRL and contractor at identified sensitive receptor locations within 50 m along the alignment (where operational stage noise level is expected to be higher than permissible limits). Appropriate mitigation measures including possibilities of installing noise barriers at sensitive receptor locations shall be determined by CMRL and contractor and agreed by MDBs.

5.3 Impacts and Mitigation Measures Due to Construction

137. Although environmental hazards related to construction works are mostly of temporary nature. Appropriate measures should be included in the work plan and budgeted for. The most likely negative impacts related to the construction works are:

- Stormwater drainage and topsoil erosion

- Traffic diversion and risk to existing building
- Air pollution due to dust generation
- Noise and vibrations
- Increased energy demand and impacts on Water
- Impact due to supply of construction material
- Disposal of construction and demolition waste
- Disposal of Hazardous Waste
- Dewatering of Excavations
- Impacts due to batching plant and casting yard
- Impacts of labour camps
- Health and Safety

5.3.1 Soil Erosion Impact

138. Certain viaduct sections and station accesses require land outside the road right of way resulting in change of landuse characteristics**.** Change in land use and excavation of soil will lead to soil erosion. Every care has to be taken to avoid damage to the topsoil (more specific) from construction sites and yards. It has to be preserved and utilized. Problems could arise from dumping of construction spoils (concrete, bricks) waste materials (from contractor camps) etc. causing surface and ground water pollution.

139. Balance C5 will have elevated track and there are 28 elevated stations. Soil excavation will be required for piling activities for metro piers. Muck from tunneling containing Bentonite would also be generated in the project.

140. Mitigation measures: The excavated soil would be used for refilling at station site but muck from piling work will be disposed at locations/sites approved by pollution control board and Tamil Nadu Congress Committee. Responsibility of disposal of this soil will lies with contractor and will be regulated by TNCGC rules. Disposal of Bentonite would be at designated landfill site.

141. Soil can be washed away from the temporary stacking of excavated soil on site before it is utilised for refill or disposed in environmentally friendly manner. Soil erosion by runoff will be controlled by installing proper drainage system.

142. Excavated top fertile soil can be preserved and used later for green belt development/ landscaping. Part of the excavated soil from piling would be re-used for refilling and balance will be disposed. Estimated quantity of disposable soil is 0.12 million cum.

143. If this muck is not contaminated by hazardous substances such as heavy metals or POPs[2], the contractor will be permitted to sell it as fill for activities outside the project; in case of hazardous contamination it will be disposed at permitted sites by licensed vendors.

144. Sites for muck disposal will be decided by CMRL before start of construction in consultation with TNPCB, Municipal Corporation/Municipalities and CMDA. The sites will be located away from residential areas, water bodies and ecologically sensitive locations as to avoid disrupting natural drainage.

145. Material will be stabilised by watering or other accepted dust suppression techniques. The muck shall be filled in the dumping site in layers and compacted mechanically. Suitable slopes will be maintained on the stockpile. Once the filling is

[2] Methods Manual of Soil Testing in India from Ministry of Agriculture or any other internationally recommended guideline/standards will be used for the soil investigation.

complete, it will be protected by low walls, provided with a layer of good earth on the top and covered with vegetation. A muck disposal plan will be prepared by Contractor, which will be approved by CMRL.

5.3.2 Traffic Diversion and Risk to Existing Buildings

146. During construction period, complete/partial traffic diversions on road will be required, as most of the construction activities are along the road. 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, traffic segregation, one-way movements, traffic diversions, acquisition of service lanes, etc.

147. Maintenance of diverted roads in good working condition to avoid slow down and congestion shall be a prerequisite during construction period.

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

- The requirement would be mainly along the central verge/ side of the road
- To minimise traffic delays, segmental construction will be employed. .

149. **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. The Contractor shall develop detailed and robust traffic management plans consistent with the Indian Guidelines on Traffic Management in work zones (IRC:SP:55-2014), prior to mobilization for respective sections with site- or station-specific plans and measures to minimize the overall impact on traffic throughout the construction and operation periods.

- All construction workers should be provided with high visibility jackets with reflective tapes as most of viaduct and station works are on the 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 behaviour through construction zones.
- The primary traffic control devices used in work zones shall include signs, delineators, barricades, cones, pylons, pavement markings and flashing lights.
- Advance traffic updates/ information on communication systems for users of affected roads.
- Efforts will be given to divert traffic to roads wide enough to accommodate extra traffic.
- Incorporation of community safety considerations into plan design, especially at locations such as CMBT to Porur, St Thomas Mount to Velakallu, Medavakkam Koot road to Perumbakkam where buildings are close to the construction site.

In order to avoid risk to life and damage during construction near and above properties which are not proposed for permanent acquisition, such properties and premises shall be vacated and residents/users temporarily shifted for duration of construction.

5.3.3 Air Pollution

150. The major sources of ambient air pollution are demolition of structures to be removed; operation of construction equipment; installation of earth retaining structures, pile driving where cast-in-situ is not feasible, blasting operations; movement of vehicles transporting construction materials, muck and waste. The pollution is in terms of fugitive dust and emissions from trucks.

151. Trucks are required to transport raw material to casting yards and Ready Mix Concrete (RMC) plants; from pre-cast yards and batching plants to construction site and between construction site and muck/waste disposal site. Vehicular emission is estimated as in Table 5.3.

Table 5.3: Emissions due to truck movement during demolition and construction

Pollutant	Emission (ton)
Carbon Monoxide (CO)	115.0
$PM_{2.5}$	3.6
Hydro-Carbons (HC)	3.6
Nitrogen Oxide (NO_x)	240.0
VOC	37.0
Carbon dioxide (CO_2)	14868.0

152. Emissions from DG sets, pollution at sites of waste disposal and muck disposal during unloading and stacking, emissions from fuel and other hazardous chemicals are among other sources of air pollution.

153. Mitigation measures which will be adopted to reduce the air pollution are listed below:

- Contractor's transport vehicles and other equipment shall conform to emission standards. The Contractor shall carry out periodical checks and undertake remedial measures including replacement, if required, so as to operate within permissible norms.
- Procedure for truck maintenance, including selection of service providers considering environmental aspects, application of low-Sulphur fuel, no idling of trucks, routine maintenance (including assurance of proper engine operations related to emissions and noise), and disposal of used oil and other fluids, batteries, and tires etc.
- DG sets compliant with emission standards will be used
- The following dust protection methods will be used:
    - Dust screens during excavation and demolition near sensitive receptors
    - Dust filters atop cement silos
    - Wet suppression for aggregate crushing and screening
    - Good quality project roads with added petroleum emulsions and adhesives, speed control, traffic control.

  - Material of specifications as per contract will be procured by Contractor from Government-approved quarries
- The Contractor will ensure that trucks carrying loads of sand and aggregate required in construction being transported to construction yards are covered and loaded with sufficient free - board to avoid spills--within the largest compartment of tanker truck. Transportation will be scheduled by time and route to minimize air pollution in habitat areas.
- The Contractor will ensure that the authorized vendor covers loads of C&D waste and hazardous waste 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. Containers carrying hazardous waste are loaded onto trucks with due care to avoid escape of fumes or spillage enroute. Transportation of muck and waste will be scheduled by time and route to minimize air pollution in habitat areas. The contractor will implement similar safeguards while transporting muck.
- The temporary muck storage areas will be maintained by the Contractor at all times until the excavate is re-utilized for backfilling or as directed by Employer. Dust control activities will continue even during any work stoppage. Soil erosion by runoff will be controlled by installing proper drainage systems using contour information It is suggested to avoid bringing soil from outside the project boundary and to use the excavated mounds for filling low lying area where it is necessary.
- The Contractor will provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt.
- Construction yards with aggregate crushing and screening, pre-casting, material and fuel storage and GC plants will be located away from habituated or ecologically sensitive areas.
- Labour residing in camps will be provided with LPG fuel for cooking.

5.3.4 Noise and Vibrations

154. Noise is a contributing factor to degradation of human health. The noise pollution will be generated by construction activities, mainly due to demolition of structures to be removed; installation of earth retaining structures; pile driving where cast-in-situ is not feasible; blasting in rock etc., and also due to the construction equipment if they are not in maintained condition. Also during such activities if existing vehicular traffic is not properly diverted then congestion and then continuous honking habits will also lead to incremental noise levels which are of indirect nature. This will also pave way for vehicular air pollution which is also to be minimized effectively. Corridor 5 construction is equipment intensive.

5.3.4.1 Noise Due to Operation of Construction Equipment

155. The major sources of noise during construction phase are due to operation of various construction equipment. Permitted number of impacts (example piling) at various noise levels is prescribed under Model Rules of the Factories Act, 1948. Actual noise from construction equipment (Lmax) measured at 50 feet distance (Construction Noise Handbook August 2006, FHWA, USA) ranged from 76 dB(A) to 84 dB(A); vibratory pile driver at 101 dB(A). The noise levels generated by various construction equipment are given in Table 5.4.

Table 5.4: Average Noise Levels Generated by Construction Equipment

Equipment	Typical Noise Level (dBA) at 50 ft from source
Air Compressor	81
Backhoe	80

Equipment	Typical Noise Level (dBA) at 50 ft from source
Ballast Equalizer	82
Ballast Tamper	83
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Concrete Vibrator	76
Crane Derrick	88
Crane Mobile	83
Dozer	85
Generator	81
Grader	85
Impact Wrench	85
Jack Hammer	88
Loader	85
Paver	89
Pile Driver (Sonic)	96
Pneumatic Tool	85
Pump	76
Rock Drill	98
Roller	74
Scraper	89
Shovel	82
Truck	88

Source: FTA Transit Noise and Vibration Guidance Handbook, May 2006

Equipment	Actual Lmax Noise Level (dBA) at 50 ft from source
Auger drill rig *	84
Compressor *	78
Dump truck *	76
Excavator *	81
Flatbed truck *	74
Front end loader *	79
Vibratory Pile driver *	101
Press Pile	70
Batching Plant	90
Booster pump	80

** Source: Construction Noise Handbook, US FHWA, Aug 2006*

5.3.4.2 Noise due to increased vehicular movement

156. During construction phase, there will be significant increase in vehicular movement for transportation of construction material. In addition to the noise mentioned above, there will also be background noise of the usual traffic resulting due to traffic congestion and confusion arising due to traffic diversion measures. Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. Temporary route direction markings will be placed in appropriate locations. During construction phase, the increase in vehicular movement is expected to increase up to a maximum of 5 to 6 trucks/hour. Table 5.5 presents the typical increase in ambient noise level due to increased vehicular movement if the background noise level is at 36dB(A).

Table 5.5: Increase in Noise Level Due to Increased Vehicular Movement

Distance (m)	Ambient noise level dB (A)	Increase in noise level due to increased vehicular movement dB (A)
10	36	72
20	36	67
50	36	61
100	36	57
200	36	52
500	36	46
1000	36	42

5.3.4.3 Impacts of Noise on Labour

157. The effect of high noise levels on the operating personnel has to be considered as this may be particularly harmful. It is known that continuous exposures to high noise levels above 90 dB(A) affects the hearing acuity of the workers/operators and hence, should be avoided. To prevent these effects, it has been recommended by Occupational Safety and Health Administration (OSHA) that the exposure period of affected persons is limited (Table 5.6).

Table 5.6: Maximum Exposure Periods Specified By OSHA

Maximum equivalent continuous Noise level dB(A)	Unprotected exposure period per day for 8 hrs/day and 5 days/week
90	8
95	4
100	2
105	1
110	½
115	¼
120	No exposure permitted at or above this level

158. To reduce the harmful effects, personnel working at high noise levels would be provided with noise protective gears such as ear mufflers, sound barriers etc. Vehicles used for transportation of construction materials would be equipped with proper silencers. Careful planning has been made to operate the construction equipment to have minimal disturbances. The construction equipment would be run only during the daytime and their noise would be monitored as per CPCB standards. Besides other measures such as use of low-noise equipment and ensuring good maintenance, trying to avoid using high-noise equipment simultaneously at the same section etc. will also be implemented to minimize construction noise.

159. Exposure of workers to high noise levels will be minimized by measures such as the following:

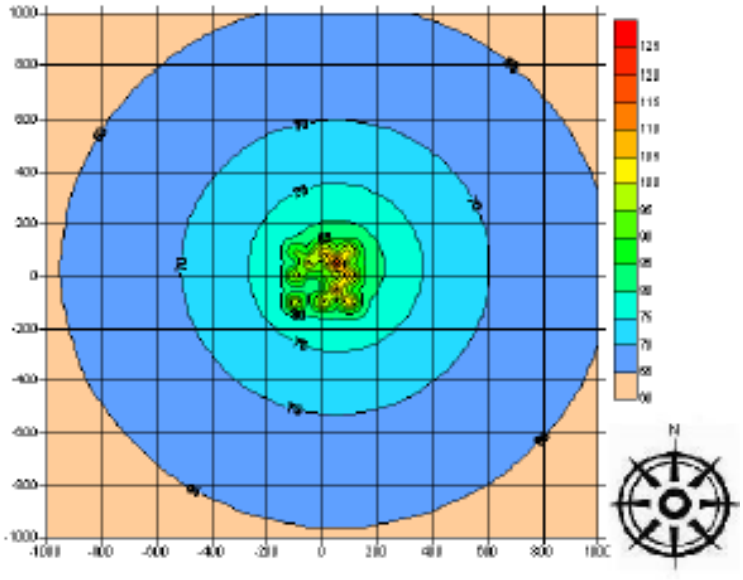
- Personal protective equipment such as passive or active ear-muffs
- Use of electric instead of diesel powered equipment
- Use of hydraulic tools instead of pneumatic tools
- Acoustic enclosures for noise generating construction equipment like DG sets
- Scheduling work to avoid simultaneous activities that generates high noise levels
- Job rotation

- Sound-proof control rooms
- Automation of equipment and machineries, wherever possible.

5.3.4.4 Predicted Noise Level during Construction Stage

160. Noise modelling during construction phase was carried out using CPCB/ MoEF&CC approved noise model "DHWANI" assuming that all the equipment emit noise simultaneously considering as worst-case scenario. The spatial variation of the predicted noise levels at an interval of 5 dB(A) without control around the project site on the area of 1 km x 1 km are shown in Figure 5.3. Modelling result shows that noise level meets the Ambient Noise Quality Standards (ANQS) 55 dB(A) (average between 6 am to 10 pm) at a distance of about 900m. Uncontrolled noise levels generated from construction equipment, in the range of 94-124 dB(A) have been considered for prediction purpose. However, the CPCB standards specify to limit the construction equipment to ensure that noise emission specifications for such equipment should not exceed 75 dB(A). The noise levels predicted here is without mitigation measures. It is assumed that with the adoption of the mitigation measures noise levels will be further restricted within very short distances from the source. With respect to occupational exposure, the permissible threshold is 90 dB(A) (continuous exposure over 8 hours). Thus, based on the modelling results it can be concluded that all sensitive receptors (i.e. labour colonies) should be located beyond 125 meters from the noise generating source location during construction activities.

Figure 5.1: Spatial Variation of Construction Equipment Noise Levels dB(A)



161. Further noise modelling is being conducted, based on the detailed engineering design to inform the incremental impacts and suggest the mitigations accordingly.

5.3.4.5 Vibration

162. Pile driving for viaduct piers and buildings generate vibrations. Apart from distance from the alignment, age and condition of buildings adjacent to the alignment determines extent of damage to such buildings due to vibration. Continuous effect of vibration on the buildings can cause damage to buildings. Buildings subjected to the vibration of more than 150 VdB might be subjected to structural damage. Historic buildings are more susceptible to vibration effect due to type of building material and design.

163. In order to evaluate the construction stage vibration levels from the project construction activities, the Construction Vibration Damage Criteria set by FTA for different building category is referred in Table 5.7 below.

Table 5.7: Construction Vibration Damage Criteria as per FTA guidelines

Building Category	PPV (in/s)	PPV (mm/s)	Approximate Lv, RMS velocity in decibels (VdB) re 1 µin/s.
I. Reinforced-concrete, steel or timber (no plaster)	0.5	12	102
II. Engineered concrete and masonry (no plaster)	0.3	7.6	98
III. Nonengineered timber and masonry buildings	0.2	5	94
IV. Buildings extremely susceptible to vibration damage	0.12	3	90

164. During construction of the underground section, TBM will be used. With a tunnel depth of approximately 25 m (vertical distance between tunnel top and floor of building above ground), the expected vibration level during operation of the TBM is approximately 99VdB in conditions of sandy and clay soil which is dominant in the project area. Attenuation of vibration is expected to be about 16 VdB resulting in a net vibration at the ground floor of the building above ground to be about 83 VdB.

165. According to the FTA manual the threshold level of vibration for beginning to cause annoyance to human beings is about 75VdB and for causing damages to extremely fragile structure is about 90 VdB. Given that the expected vibration level at the ground floor is about 83 VdB, people living in the ground floor of houses located immediately above the tunnel will feel the vibration and may get annoyed when the TBM is operational. However, it is unlikely that any structural damages will take place.

166. In the case of vibrations from road traffic and pile driving, very deep barriers (in excess of 10 m) were found to reduce vibration. In-ground barriers are trenches that are either left open or filled with a material (such as bentonite or concrete) that has stiffness or density significantly different from that of the surrounding soil. However, trenches may be too costly for situations involving houses. They could perhaps be justified for larger buildings with strict vibration limits, such as operating theatres of hospitals or high-tech factories with sensitive processes. An economical alternative to trenches in a residential area could be a row of lime or cement piles of diameter 0.5 m to 1 m and a depth of 15 m in the right-of-way adjacent to the road. However, the effectiveness of such pile-walls has not yet been demonstrated[3]. Cast-in-situ piling will be deployed at locations with sensitive receptors so as to reduce vibration.

167. At locations where the alignment is close to sensitive receptors, the contractor shall implement:

- The detailed noise and vibration analysis (mathematical modeling) at sensitive receptors based on final engineering designs should be carried out, based on which, a set of mitigations should be prepared and shared with all lenders for review, prior to commencement of construction
- Pre-construction structural integrity inspections, including visual inspections of buildings of cultural or historical significance

[3] NRC-CNRC Construction Technology Update No. 39, 2000, Vibrations in Buildings by Osama Hunaidi and A review on the effects of earth borne vibrations and the mitigation measures, BOO Hyun Nam et al, IJR International Journal of Railway, Sept 2013.

- The sensitive receptors have to be isolated from heavy construction noise generated. This is possible by erecting reinforced 2 m tall GI sheet barrier around the area where heavy construction works is undertaken
- Information dissemination about the construction method, probable effects, quality control measures and precautions
- Monitoring during construction

168. Further vibration modelling will be conducted, based on the detailed engineering design to inform the incremental impacts and suggest the mitigations accordingly.

5.3.5 Increased Energy Demand and Impacts on Water

5.3.5.1 Increased Energy Demand

169. Construction employs energy intensive equipment round the clock. High illumination lighting and minor tools and equipment impose increased demand on energy consumption due to construction.

170. The contractor shall use and maintain equipment so as to conserve energy and shall be able to demonstrate the abovementioned upon request of CMRL. Measures to conserve energy include maintenance of energy efficient tools, plant and equipment of; lamps and DG sets to comply with TNPCB norms; Promoting awareness through energy saving trainings.

5.3.5.2 Increased Water Resource and Quality

171. Water for dust suppression (sprinkling) and tire washing will be sourced from surface runoff, wastewater from construction sites, construction yards and seawater. Used water from tyre washing will be re-used. Water for curing of concrete will be sourced from municipal supply, surface runoff or water from dewatering. Water for concrete batching plant and labour camps will be sourced from treated municipal water. Water consumption during construction is of the order of 448 KLD.

172. After precipitation, waste water from construction yards, sites and labour camps will be discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. In view of the distributed nature of the linear construction and quantities of waste water, it is not proposed install sewage and effluent treatment plants by CMRL.

173. Construction yards with aggregate crushing and screening, pre-casting, material and fuel storage and GC plants as well as excavate/waste disposal sites will be located away from inhabited or ecologically sensitive areas.

174. Construction materials, oils and greases from construction sites; used water from the RMC plant; water used for dust suppression at aggregate crushers are sources of pollution of surface water bodies or groundwater. Sewage from labour camp can also pollute surface water bodies or groundwater. Groundwater which seeps into excavations can get contaminated by chemicals used in construction and consequently pollute groundwater outside the excavations upon dewatering.

5.3.6 Impact Due to Supply of Construction Material

175. Metro construction is a material intensive activity. Huge quantity of different construction materials will be required for construction of elevated metro corridor and stations. These shall be sourced from the nearest source. 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. So, the construction material shall be sourced only from legalized and approved quarries.

5.3.7 Disposal of Construction and Demolition Waste

176. Waste construction material, demolition waste and hazardous waste from construction equipment and construction vehicles can pollute air, water and soil. The procedure of demolition will be conducted as per the demolition plan prepared by the Contractor in consultation with CMRL. The existing structures should be demolished one after another cautiously. The Construction and Demolition (C&D) waste needs to be reused/recycled as it has the potential to save natural resources (stone, river sand, soil etc.) and energy. C&D waste generated from metro construction has potential use after processing and grading. The contractor will segregate and temporarily store the C&D waste till the vendor takes it away for recycling and disposal at authorized facilities.

177. C&D waste is part of solid waste that results from land clearing, excavation, construction, demolition, remodeling and repair of structures, roads and utilities. C&D waste has the potential to save natural resources (stone, river sand, soil etc.) and energy, its bulk which is carried over long distances for just dumping, its occupying significant space at landfill sites and its presence impedes processing of bio-degradable waste as well as recyclable waste. C&D waste generated from metro construction has potential use after processing and grading. The contractor will segregate and temporarily store the C&D waste till the vendor takes it away for recycling and disposal at authorized facilities.

178. Mitigation Measures: The C&D waste would be handled and disposed off to waste processing facility or for back filling of low lying areas only if the area is covered afterwards with a good quality layer of topsoil of sufficient thickness, leaving no significant impact on environment. Bentonite slurries used in diaphragm wall construction should be reconditioned and reused wherever practicable. The disposal of residual used bentonite slurry should follow the international good practice.

5.3.8 Disposal of Hazardous Waste

179. Hazardous waste would mainly arise from the maintenance of equipment which may include used engine oils, hydraulic fluids, waste fuel, spent mineral oil/cleaning fluids from mechanical machinery, scrap batteries or spent acid/alkali, spent solvents etc.

180. The contractor will ensure that hazardous wastes from construction activity and equipment are labeled, recorded, stored in impermeable containment and for periods not exceeding mandated periods and in a manner suitable for handling storage and transport. The contractor shall maintain a record of sale, transfer, storage of such waste and make these records available for inspection. The contractor shall get Authorized Recyclers to transport and dispose Hazardous Waste, under intimation to the Project Authority.

5.3.9 Dewatering of Excavations

Table 5.8 shows ground water levels upto 10 m below ground in pre-monsoon as well as post-monsoon seasons and rise in water level of upto 4 m in 80% to 90% of observation wells in Chennai district between pre-monsoon and post-monsoon months. It indicates that significant dewatering of excavations might be required. In view of use of cast in situ piles with liner, dewatering of excavations will be very small.

Table 5.8: Ground water level in Chennai District

Month/year	% of observation wells in each range of water level (m) below ground level			Rise (m) in water level	Fall (m) in water level
	0 to 2	2 to 5	5 to10		
May 2013	*8*	54	38	60% wells <2m, 30% wells 2m to 4m	100% wells <2m
January 2014	*36*	36	29		
May 2014	*14*	33	53	50% wells <2m, 30% wells 2m to 4m, 20% wells >4m	Zero
January 2015	*56*	25	19		
May 2015	*14*	50	36	60% wells <2m, 30% wells 2m to 4m, 10% wells >4m	Nil
January 2016	*41*	47	12		
May 2016	24	*59*	17	83% wells <2m	86% wells <2m
January 2017	14	*79*	7		
May2018	Nil	*25*	75	80% <2m	90% <2m
January 2019	15	*55*	30		

(*CGWB Yearbooks 2013-14,2014-15,2015-16,2016-17,2017-18,2018-19 for Tamil Nadu and Puduchery)*

181. Bentonite used to seal infiltration of water through soil is not classified as harmful. This water will be treated and added to groundwater to recharge.

5.3.11 Impacts Due to Batching Plant and Casting Yard

182. During construction phase there would be establishment and operation of Batching Plant and Casting Yard which would be located in an area designated and allotted by CMRL away from habitation. If possible, these facilities will be located at least 500 m away from habitations and at least 1 km away from environmentally or ecologically sensitive area.

183. There would be significant movement of men, material and machinery in batching plant and casting yard. It is expected that both batching and casting yard would be located at same complex. Huge quantity of cement, aggregates and other construction materials would be used in batching plant and casting yard. There would be generation of dust, noise, flue gases and other contaminants from the working of heavy machinery for handling and transporting the construction materials. The mitigation measures for different aspects, such as the soil and groundwater quality baseline shall be collected by contractor prior to mobilization and shall be monitored during construction, have been elaborated in EMP.

5.3.12 Impacts of Labour Camps

184. During the progress of the work, the construction contractors work activities provides the erection and to maintain the necessary (temporary) living habitats and allied facilities for the workforce up to their living standards and scales up to be approved by CMRL. Improper disposal of municipal solid waste generated by labour camps can pollute surface water bodies and groundwater. Burning of waste can cause air pollution. Construction workers are more prone to infectious diseases due to unsafe sexual activity and lack of sanitation facilities (water supply and human waste disposal) and insect vectors. Problems could arise due to cultural differences between workers from outside and local residents.

185. As per Building & Other Construction Workers (BOCW Regulation of Employment and Conditions of Service) Act, 1996 the employer (contractor) is liable to arrange for sanitation, health care facilities of labours, free of charge. Labour camps will be in full compliance of BOCW Act.

186. It is estimated that about 5,720 persons will work during peak construction activity on site and casting yards. Estimated total population in the labour camps will be 5,120. The water requirement at camps will be 692 KLD, wastewater generation 598 KLD & municipal solid waste generation 1.5 ton per day. This is tentative and will vary depending on the construction schedule during construction.

- **Water supply:** Uncontaminated water for drinking, cooking and washing, health care.
- **Sanitation Facilities:** Construction sites and camps shall be provided sanitary latrines and urinals. Sewerage drains 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 by providing septic tanks, built and operated so that no health hazard occurs and no pollution to the air, ground or adjacent watercourses takes place. Garbage bins must be provided in the camp and regularly emptied and the garbage disposed in a hygienic manner. Labour camps should also be provided with proper ventilations and air cooling system.
- **Solid Waste Management:** Solid waste generated will have to be disposed in compliance with Municipal Solid Waste (Management & Handling) Rules, 2000, as amended to date. Municipal solid waste will be collected and taken away and disposed by municipality. Solid waste management facilities will be arranged by the construction contractors.

5.3.13 Health and Safety (H&S)

5.3.13.1 Occupational H&S

Labour Camps

187. Prior to construction, necessary (temporary) living facilities for project workers will be provided by the contractor. Locations of such camps, their layout and level of facilities so as to minimize health risks will be put up for approval of CMRL, CMDA and Public Health Officer of Greater Chennai Corporation. As per Building & Other Construction Workers (BOCW Regulation of Employment and Conditions of Service) Act, 1996 the employer (contractor) is liable to arrange for sanitation, health care facilities of labourers free of charge. Labour camps will be in full compliance of BOCW Act. Uncontaminated water will be provided for drinking, cooking and washing, health care.

188. Waste water from cooking, bathing and washing including sewage from toilets will be discharged into municipal drains. Such waste water will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. In view of the distributed nature of the linear construction and quantities of waste water, it is not proposed to install sewage treatment plants by CMRL for construction and operation phases. Sewerage drains should be provided for the flow of used water outside the camp. Garbage bins will be provided in the camp and regularly emptied into municipal bins. Municipal solid waste will be collected and taken away and disposed by municipality.

189. The Contractor will implement COVID-19 guidelines and Operating Procedures as part of the Contract. Residents of worker camps will be sensitized about need to implement precautions and trained in social distancing, sanitizing, avoiding groups; arrangements for thermal scanners and provision of sanitisers, face masks, gloves etc. will be made by contractor. Site record of COVID-19 hospitals will be maintained and fully equipped ambulances will be available to transport sick camp residents to hospitals. Daily disinfection of camps will be carried out.

Worker Safety in construction areas

190. Construction works will be executed as laid down in the Safety Health and Environment (SHE) Manual as applicable to Balance C5. The applicable sections are i) Control Document; ii) Health and Safety Manual; and iii) Environmental Management Arrangements.

191. Environmental Social Health and Safety **(**ESHS) Requirements comprising sections i),ii) and iii) above are included in the tender documents for contractor to comply with for elevated construction. Compliance with sections i) and ii) is mandatory, section iii) is intended to provide guidance to the contractor. While complying with this SHE Manual, site-specific and construction work-specific procedures will be prepared by the Contractor and approved by CMRL. Hazards and requisite safety measures related to working at height are of primary focus on this corridor.

192. Control comprises: Legal requirements; standards; Contractor`s organisation and interfaces with CMRL; procedures to identify hazards and estimate risk, hazard mitigation measures; emergency response plan; resources; arrangements for training, inspection, communication, compliance, reporting, documentation and audit, review; complaint addressal.

193. Health and Safety Manual covers: Contractor organisation; accidents; hazards and risks; emergency preparedness plan; signage; industrial health and welfare; works - heights, excavations, electrical and mechanical; gases; machinery; equipment; blasting; formwork; piling; PPE; medical facilities; firefighting; traffic management; housekeeping; launching; batching plant; transport; security; explosives; general safety; flooding etc. As part of medical facilities for workers, the Manual mentions support to the HIV/AIDS control agency.

194. The mandatory workplace measures are: health care awareness and clinics, first aid facilities, day crèche, shelter at workplace, canteen facilities.

COVID-19

195. WHO has declared COVID-19 as a pandemic which has affected entire world including India. In view of the prevailing COVID-19 pandemic, the Contractor and workers would need to take additional measures to avoid the spread of the disease and shall follow various guidelines/guidance notes issued by the national/state government, WHO, ILO,

World Bank/IFC from time to time. As described in these guidelines, the Contractor shall undertake a COVID-19 risk assessment of project area and prepare a COVID-19 Response and Management Plan (C-R&MP) and submit to CMRL and GC for approval. Furthermore, the Standard Operating Procedures (SOPs) and Guidelines for Construction Sites for COVID-19 Outbreak developed by National Real Estate Development Council will be mandatory for contractors to follow.

196. The Contractor will implement COVID-19 guidelines and Operating Procedures as part of the Contract. The procedures are:

- Thermal scanning, hand sanitization and face masking at entry and exit to/from work areas; hand gloves for those who handle material received from outside work area;
- social distancing at toilets and eating areas;
- daily disinfection of site, equipment and vehicles; site record of COVID-19 hospitals; fully equipped ambulances to transport sick workers to hospitals;
- signage and regular awareness sessions;
- staggered hours of work start and close to ensure social distancing at gates;
- all construction material arriving at site should be left idle for 3 days before use to ensure safe usage;
- non-touch garbage bins with biodegradable garbage bag for waste collection;
- proper disposal of garbage bags along with daily cleaning and sanitization of bins;
- In addition fully equipped ambulances will be available to transport the sick to hospitals.

5.3.13.2 Community H&S

197. During construction, the impacts on community H&S are due to exposed to traffic, noise, dust and vibration disturbance and the risk of road traffic accidents are anticipated.

198. To prevent community H&S issues during construction, contractor on coordination with implemented measures such as provide the construction camps with facilities such as health care clinics, places of worship, and occasional entertainment, preparation of implementation of traffic management plan during construction, access to buildings, awareness and information sharing, and implementation of CMRL SHE Manual.

199. Activities such as girder launching will be done during off peak hours of day and night. Tasks involving welding will be taken up with due real-time on-site guidance to road users: barricading is usually inadequate to mitigate this hazard.

200. Any incidence of COVID-19 and similar illnesses will be immediately communicated to the health authorities: suitable channels of communication with citizens located in proximity of worker camps will be maintained.

201. In case of road closure or traffic diversion, the Contractor will ensure that information on the timing of construction works and notifications of road closure (if any) is provided via local media (radio, TV, newspaper etc.) or through the local community heads.

5.4 Impacts and Mitigation Measures due to Project Operation

202. Positive Impacts: Key positive benefits are i) reduced fuel consumption and air pollution; ii) mobility, safety and reduced congestion and accidents; iii) increased employment opportunities and economic activity; and iv) enhanced skyline.

203. Negative Environmental Impacts: Along with many positive impacts, the following negative impacts during operation are anticipated:

- Noise and Vibrations
- Water supply and sanitation at stations
- Energy consumption at stations
- Health and Safety

5.4.1 Noise and Vibrations

204. Airborne noise level increases with train speed, decreases with ballasted tie-welded track with elastic fastenings and absorbing pad and well maintained wheel and rail condition. Vibration is found to be higher with higher speeds and lower with heavier transit structure. The vibration is generally caused from rail-wheel interaction. This can be reduced by minimizing any surface irregularities on the wheel and rail. To minimize the vibration shock absorbing pad has to be provided and there has to be a distance between rail seat assembly and concrete plinth.

205. For elevated corridors, ballast less track structure is supported on two layers of rubber pads to reduce noise and vibrations. In addition, baffle wall as parapets will be constructed up to the rail level so as reduce sound levels. Noise at source will be controlled or reduced by incorporating suitable feature in the design of structures and layout of machines and by use of resilient mounting and dampers etc.

206. These noise generations for metro operation activities have been recorded from past experience from existing Metros in India as well as project authorities. The following data includes various noise levels in above activities. 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. Airborne noise is radiated from elevated structures. The noise level at 2 m distance from the rail alignment is about 73 dB(A) which is higher than the CPCB permissible limit of 65 dB(A), and is much higher than the 50 dB (A) daytime limit for silence zone The noise level reduces with distance logarithmically. Refer Tables 5.9 and 5.10.

Table 5.9: Exterior Noise Levels in Metro Stations

S. No	Description	Average Noise Levels dB(A)
		Elevated tracks
1	Background Noise Level	64.0± 1.5
2	Train entering the Platform (Max)	84.0± 1.5
3	Train leaving the Platform (Max)	84.0± 0.5
4	Train stopping in Platform	79.0± 0.0
5	Train stationary in Platform	76.0± 0.5
6	Train starting from Platform	78.5± 1.0
7	Train braking	86.0± 0.0
8	Announcement	74.0± 0.5
Overall		**76.0± 7.0**

Table 5.10: Interior Noise Levels in Metro Trains

S. No	Description	Average Noise Levels dB(A)
		Elevated tracks
1	Train stationary	62.0± 1.0

2	Train starting	62.0± 1.0
3	Train motoring	70.0± 2.5
4	Train coasting	72.0± 2.0
5	Train at max. speed	78.0± 1.0
6	Train decelerating	69.0± 0.5
7	Train stopping	64.4± 1.0
8	Train braking	74.5± 1.0
9	W/R Noise	75.0± 1.5
10	Door operations (max.)	-
Overall		**69.0± 5.0**

Source: Studies carried out by Central Road Research Institute (CRRI) for metro projects in India

207. Noise barriers are recommended with noise reduction possibilities in Table 5.11.

Table 5.11: Noise Barrier for Noise Reduction

Place of Noise Barrier	Height of noise barrier	Noise reduction
On the viaduct	4m (3.5m Absorptive+0.5m transparent) green color	15 dB(A)

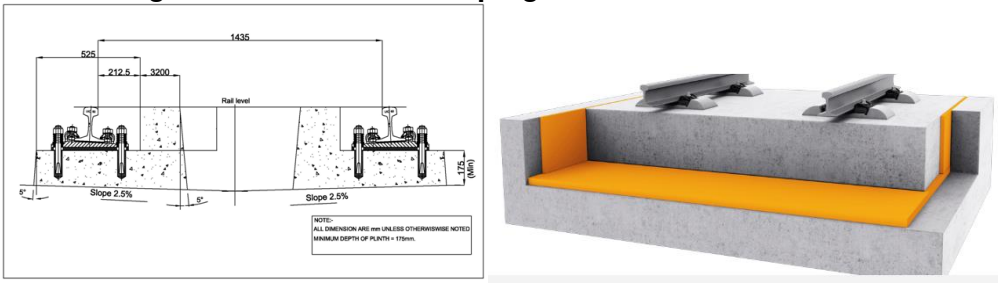
208. The study found that noise reduction is possible around 15 dB(A) after installation of noise barrier. Therefore, study suggested that noise barrier is the best option to reduce the instantaneous noise generated by metro.

209. Furthermore, the noise barriers consisting of 15mm thick UV coated clear transparent polycarbonate sheets meeting the criteria for acoustic performance as per EN 1793 and mechanical and structural performance as per EN 1794 including necessary structural galvanized steelwork and rubber gasket all around, have been included in the tender document. The sound transmission class rating corresponding to sound attenuation of 30dB or above is required.

210. Elastic pad between seat of the rail and the track slab as well as between track slab and the superstructure beneath it will reduce vibration transmitted from the track and superstructure. Indicative pictures are shown in Figure 5.4.

211. The detailed analysis (computer modeling) of noise and vibration is being conducted based on the detailed engineering design, and will be finalized prior to contractor's mobilization. The analysis will form the supplementary study of this EIA.

Figure 5.4: Vibration Damping Devices in Track



Source: Getzner Werkstoffe

5.4.2 Water and Sanitation at Stations

212. Water demand at stations for cleaning is 481 KLD**.** The water requirement for the stations will be met through the public water supply system.

213. Arrangement of water will have to be made at each station separately with proper drainage system for wastewater. Municipal water supply will be supplemented by rainwater harvesting along viaduct and rooftop of elevated stations. Sewage of 409 KLD will be generated. Wastewater will be led into municipal sewage system.

214. Solid waste generation from passengers at stations is likely to be 301 ton per day. Non-hazardous solid waste generated in stations will be collected and transported to local municipal bins for onward disposal to disposal site by municipality.

215. Mitigation Measures: After precipitation, waste water from construction yards, sites and labour camps will be discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules (EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. In view of the distributed nature of the linear construction and quantities of waste water, it is not proposed install sewage and effluent treatment plants by CMRL. The water requirement for the stations will be met through the public water supply system. Municipal water supply will be supplemented by rainwater harvesting at elevated stations. As an environmental conservation measure, to conserve and augment the storage of groundwater, it is proposed to construct rainwater harvesting structure of suitable capacity at the elevated stations and in the elevated alignment. Each pillar can have inbuilt downpipes to collect the rainwater from the viaduct and rooftop of elevated stations and then led into underground tanks through layers of sand and gravel. At annual rainfall of 1,541mm, potential for rainwater harvesting is 5.08 lakh cum per year on Corridor 5.

5.4.3 Energy Consumption at Stations

216. Stations impose significant demands on energy. In addition, traction, rolling stock and train control systems also require reliable sources of grid and standby power, high intensity energy, as well as efficient equipment. Table 5.12 presents the power demand of alignment during operation.

Table 5.12: Power Demand

Load	2025		2035		2045		2055	
	Normal	Emergency	Normal	Emergency	Normal	Emergency	Normal	Emergency
Thiruverkadu GSS-Mugalivakkam RSS (Chainage 7186 to 13366) 6.180km								
Traction	2.46	6.34	3.24	8.36	3.90	10.05	4.42	11.39
Auxiliary	5.13	7.70	6.38	9.40	7.18	10.70	7.70	11.55
Total	7.59	14.04	9.62	17.76	11.08	20.75	12.12	22.94
Alandur GSS-St Thomas RSS (Chainage 13366 to 23109) 9.743km								
Traction	3.88	8.59	5.11	11.33	6.15	13.62	6.97	15.44
Auxiliary	2.57	5.13	3.02	6.03	3.53	7.06	3.85	7.70
Total	6.45	13.72	8.13	17.33	9.68	20.68	10.82	23.14
Kadaperi GSS to Medavakkam RSS (Chainage 23109 to 34947) 11.838km								
Traction	4.71	9.22	6.21	12.16	7.47	14.62	8.47	16.57
Auxiliary	2.57	5.13	3.02	6.03	3.53	7.06	3.85	7.70
Total	7.28	14.35	9.23	18.19	11.00	21.68	12.32	24.27
Mambakkam GSS to Perumbakkam RSS (Chainage 34947 to 46272) 11.325km								
Traction	4.51	9.22	5.94	12.16	7.15	14.62	8.10	16.57
Auxiliary	2.57	5.13	3.02	6.03	3.53	7.06	3.85	7.70
Total	7.28	14.35	9.23	18.19	11.00	21.68	12.32	24.27

217. Requirement of electrical energy for facilities at stations will be optimized by proper use of natural day/night light and design of passenger flow inside stations and on streets outside stations. Installations for solar power will be implemented in stations where feasible.

218. **Green Buildings.** In accordance with the GRIHA (version 2015) norms, the following measures will be implemented to a feasible degree in the stations and depots.

- Control annual heat gain through favorable orientation and design of facades
- Site planning according to contours
- Site plan designed to preserve existing vegetation/ existing water bodies / other topographical features like boulders etc.
- Manage storm water on site through rainwater harvesting
- Mitigate heat island effect by ensuring that building surface visible to sky is shaded by trees. Ensure zero SWD post-construction by means of ground water recharge and recharge of groundwater aquifers by rainwater. The building shall be designed to incorporate low ODP materials, indoor air quality and comfort, low-VOC paints and adhesives, reduced landscape water demand, sustainable building materials and renewable energy utilization etc.
- For the utilization of renewable energy, wherever feasible, installations for solar power can be implemented on roof of elevated stations. Installation and maintenance of solar power infrastructure is proposed to be awarded to developer along with Power Purchase Agreement (PPA). The power shall be purchased by CMRL on the basis of the unit rate specified by Power Purchase Agreement (PPA).

219. In conformity to other corridors in Chennai, the following design elements are proposed which increase energy efficiency and safety:

- High voltage electric traction which have ability to carry high traffic at a reduced cost with higher efficiency of operation
- Rolling Stock is of light weight stainless steel / aluminium resulting in energy efficiency and improved life thus improving resource utilization and environmental quality. Standard Gauge rolling stock results in recurring saving in energy consumption during operation as for the same passenger carrying capacity, gross weight of a metro coach is lower.

5.4.4 Visual Issues

220. The introduction of metro system implies a change in streets through which it will operate. An architecturally well designed elevated section can be pleasing to the eyes of beholders. Recent metro rail projects have attempted to incorporate this objective in their designs. Since a low profile would cause the least intrusion, the basic elevated section has been optimized at this stage itself.

221. During design stage, the stakeholder engagement will be conducted to disclose the station designs and to incorporate the feedbacks.

5.4.5 Health and Safety

5.4.5.1 Occupational H&S

Electromagnetic interference (EMI)

222. Electromagnetic Interference (EMI) in metro railway can disturb electronic circuits in 3 ways:

- EMI in railway infrastructure like signaling caused by rolling stock. Considering the criticality of signaling, such disturbances can cause accidents and safety of staff as well as passengers.
- EMI in environment caused by rolling stock. The railway can impact environment upto at least 10m from the track (Railway EMI impact on train operation and environment, A Morant etal, IEEE, Dec 2012)
- EMI in rolling stock caused by environment.

Electromagnetic radiation

223. It can cause adverse health impacts on people living or working very near the railway. Among other studies, a large U.S. case-control study (638 cases and 620 controls) to test whether childhood acute lymphoblastic leukemia is associated with exposure to 60-Hz magnetic fields was published by Linet et al. (1997). Measurement results are suggestive of a positive association between magnetic fields and leukemia risk. (*ICNIRP Guidelines For Limiting Exposure To Time-Varying Electric, Magnetic And Electromagnetic Fields (Up To 300 Ghz) Published In: Health Physics 74 (4):494-522; 1998)*

COVID-19

224. COVID-19 transmission poses much higher risk during operation than on construction sites due to sealed coaches and density of commuters. passenger densities in stations also pose a grave risk. Social distancing will require increased number of services for a given level of demand.

225. GoI protocols governing COVID-19 precautions shall be fine-tuned; staff shall be trained; staff and commuters shall be informed of precautions such as social distancing, sanitizing; arrangements for stationary and hand-held thermal scanners; provision of sanitizer pedestals, vending machines of face masks and gloves etc. will be provided in stations; site record of COVID-19 hospitals; protected ambulances at stations; daily disinfection of operating rooms, circulation spaces, equipment and vehicles..

5.4.5.2 Community H&S

Electromagnetic Interference and Electromagnetic Radiation

226. Electromagnetic Interference and electromagnetic radiation can adversely impact public safety. Detailed specification and layouts of equipment e.g. power cables, rectifiers, transformer, E&M equipment etc. will be framed to reduce conducted or radiated emissions as per appropriate international standards. Electromagnetic Compatibility and maximum electromagnetic emission levels of whole railway system to the outside world measured at the railway boundary fence will comply with EN50121-2.

Operation related H&S

227. During operation accidents related to train operation like collision, derailment, fire, power outages, or operation stoppage may occur. Administration of safety during operations is governed by Chennai Metro Safety Manual. The Manual defines “Accident” as any occurrence which causes or has the potential to cause death or injury to staff, passengers or other persons or cause damage to the property of the Metro Railway, passengers or other persons. The Manual classifies accidents in Class A to Class L covering the following incidents:

- Failure of signal system, Failure of traction power supply, Failure of rolling stock, Failure of track and structures

- Failure of Platform Screen Doors / car doors
- Natural disasters
- Fire, explosion, security threats
- Theft etc. or any other event which reflects a system failure but has not affected train operation.

228. The Manual prescribes

- Duty Lists of Train Operator, Station Controller, Traffic Controller at OCC, site officers and security personnel
- Accident reporting
- Rescue and Relief Arrangements
- Accident Investigations and Enquiries.

229. Procedures to be implemented during operational emergencies are included in the Emergency Preparedness and Response Plan in this report. Design of the metro system provides for operational safety. Some of such features are mentioned below:

- In the unlikely event of simultaneous tripping of all the input power sources or grid failure, the power supply to stations as well as to trains will be interrupted. A standby silent type DG set of adequate capacity at stations will sustain the following: essential lighting, signaling, and telecommunications, fire-fighting system and lift operation. Coaches will be reserved for women, seats in all coaches will be reserved for women, elderly and disabled. Bus stops, pick up drop off points will be well lit and provided with messaging.
- To provide a high level of safety with trains running at close headway ensuring continuous safe train separation, eliminate accidents continuous speed monitoring and automatic application of brake in case of disregard of signal / warning by the driver, and provides safety and enforces speed limit on section having permanent and temporary speed restrictions Automatic Train Protection and Automatic Train Supervision sub-systems will be installed.
- CCTV system will provide video surveillance and recording function for the operations to monitor each station. The monitoring will be possible both locally at each station and remotely from the operation control center. All trains will have public address systems to warn the passengers of any emergency situation.

COVID-19

230. Face protection and hand sanitizing are of critical importance. Testing, transportation and hospital facilities of a much higher order of safety will be provided at stations. Standard Operating Procedure (SOP) for operation of metro services protecting from COVID-19 infection has been prepared by all metro operators in India and attached as Annexure 8. Chennai Metro SOP comprises the following actions:

- Number of passengers will be regulated at entry to station so that social distancing inside stations and on trains is maintained
- Alternate seats on platforms and on trains will be marked out of bounds
- Dwell time of trains at stations will be increased to 50 seconds (instead of 30 seconds pre-COVID-19) to allow more time for boarding/alighting
- Intake of fresh air on trains will be increased; temperature maintained at 24 to 30 degrees Celsius
- Trains will not stop at stations falling in containment zones; such stations will not be open to users
- Some stations may be skipped to ensure social distancing
- Train doors to be open for 2 minutes at terminal stations to let fresh air infusion.

5.5 Chance Finds

231. Balance C5 is in urban areas and there may be possibilities that some artifacts could be found during piling and excavation work.

232. Mitigation Measures: before start of civil work the contractor and CMRL will coordinate with Tamil Nadu State Department of Archaeology to reconfirm that there is presence of buried artifacts along the metro line alignment. No piling or excavation will be allowed unless cleared by the Archeological Department.

233. All workers will undergo a briefing with the Archaeology Department to ensure safeguarding of heritage resource and cultural/religious practices.

234. A proof of compliance to this requirement to include the name of participants and date and location of briefing will form part of the monthly report to CMRL.

235. The contractor will comply with the FIDIC Sec. 4.24 on Fossils. Recording (including chain of custody) will be made by the contractor to be validated by the GC ~~CSC,~~ and expert verification will be made by the Archaeology Department. Temporary work stoppage in the immediate area of the chance find for up to 72 hours to allow for the on-site representative of Archaeology Department to visit the site to make an assessment and provide instructions. Work in the areas adjacent to the chance find will continue as provided in the detailed design.

5.6 Benefits

236. Metro rail systems have an advantage over other modes of transport because they provide higher carrying capacity, faster, smoother, and safer travel, occupy less space, and are non-polluting and energy-efficient. To summarize the benefits of a metro rail system:

- **Reduced Air Pollution:** Reduction in air pollution level is the single most important indications due to metro rail alignment.
- **Increased Employment Opportunities:** During the period of construction manpower will be needed for various project activities. In post-construction phase, about 841 people will be employed for operation and maintenance of the system. In addition, more people would be indirectly employed in allied activities.
- **Improved Economy:** The project will facilitate movement of people from different parts of Chennai. Corridor 5 will yield benefits in terms of growth in economic activity due to better accessibility, savings in fuel consumption, corresponding reduction in cost of road construction and maintenance, reduction in vehicle operating costs, savings in travel time, improvement in quality of life and reduction in loss of productivity due to health disorders resulting from pollution.
- **Mobility Safety and Reduced Accidents:** The metro network increases the mobility of people at faster rate. The proposed corridor will provide more people connectivity to other parts of the city. Metro journey is safe and result in reduced accidents on roads.
- **Reduced Fuel Consumption:** Based on number of daily vehicle kilometre reduction, daily reduction in fuel (diesel and petrol) consumption has been estimated. The reduction has been estimated based on retiral - without addition - of pre-BS VI vehicles from year 2020 onwards; in accordance with the report commissioned by Niti Aayog, 100% of 3 wheelers and buses and 40% of private 2 wheelers and cars have been assumed to be electric from year 2030 onwards. The benefit is an interplay between shift from road modes to Metro and shift from more polluting pre-BS VI road vehicles to less polluting BS VI road vehicles. Reduction in

fuel consumption is reported in Table 5.13. The reduction of air pollution is presented in Table 5.14.

Table 5.13: Reduction in Fuel Consumption (million litre per year)

	2025	**2035**	**2045**
Diesel	57.3	0.1	0.2
Petrol	3.0	2.4	3.7

Table 5.14: Pollution Reduction (ton/year)

Pollutant	**2025**	**2035**	**2045**
CO	1624	231	222
PM	35	1	1
$HC+NO_x$	1495	37	36
CO_2 (net)	104803	209148	127605
Treatment cost (Rs million per year)	368	132	90

6. ANALYSIS OF ALTERNATIVES

6.1 Introduction

237. This section presents the symmetrically compared feasible alternatives to Balance C5. Alternatives such as other sources of transport (road, mono-rail, suburban rail), proposed design etc. have been considered and analyzed for its likely impacts on various environmental parameters. Additionally, an evaluation of potential environmental impacts in terms of 'with' and 'without' project scenario has been considered for the justification of the project. This section also presents a discussion on how environmental parameters were assigned due importance and considered in the analysis of alternatives.

6.2 Different Modes of Transport and Need to Increase Public Transport Share

238. The urban transport model was developed as part of Feasibility Study for travel demand assessment and to arrive at influential mass rapid transit corridors. The need for quantum increase in transport capacity of the current network by means of rapid transit along proposed corridors is indicated by inadequacy of road capacity. Major roads along the composite corridor 5 are forecast to function beyond respective design service volume in absence of the Corridor. The study estimated peak hour peak direction traffic (PHPDT) of 30,850 for composite Corridor 5 with a total daily ridership of 0.90 million passengers in horizon year 2035 in Phase II.

239. The Comprehensive Mobility Plan for CMA 2018 identified 8 mass transport corridors which are forecast to carry peak hour peak direction traffic ranging from 11000 to 35000 which is more than capacity of bus transport in form of discrete buses. One of these 8 corridors is from Madhavaram-Sholinganallur-ECR.

240. The development of the two scenario starts with estimating the traffic and the modal share in these scenarios for the system. As per travel demand forecast on revised network in DPR 2018, composite Corridor 5 will cater to daily boarding of 7.2 lakh in 2025 and 18.5 lakh in 2055; maximum sectional PHPDT will correspondingly increase from 17,539 to 35,714. On Balance C5, PHPDT across sections will vary between 14,878 and 2021 in year 2025; 34,503 and 3248 in year 2055.

6.3 Analysis With and Without Project Scenario

241. In case Balance C5 is not constructed, the city will be deprived of the following benefits:

- Economic prosperity
- Mobility and access to economic opportunities
- Comfort and Safety, particularly for women and differently abled people
- Traffic Congestion Reduction, Reduction in Number of Buses
- Reduced Fuel Consumption, Reduced Air Pollution
- Carbon Dioxide and Green House Gases (GHG) Reduction
- Optimality in transportations

242. Benefit in terms of reduction in air pollution due to operation of Metro is estimated in Chapter 5. In view of the large net positive impacts consideration of 'no development alternative' is a non-starter and has thus not merited any further consideration.

6.4 Comparison of Alternative High Capacity Modes

243. Table 6.1 presents comparison of unit life cycle costs of Metro, Light Rail Transit (LRT) and Bus Rapid Transit (BRT). The costs pertain to traffic demand forecast on MDB project corridors and are based on data for such systems operating or evaluated for Indian conditions.

Table 6.1: Cost Comparison of urban mass transit systems

S.N	**Balance C5**	**Forecast traffic demand in year 2055 PHPDT (length of section)**	**Life Cycle Cost (Rs lakh per seat)** *rounded off*		
			Metro elevated	**Light Rail elevated**	**BRT at grade**
1	CMBT to Ok. Tho (29.142km)	1000 to 10000 (Puzhithivakkam to Sholinganallur elev 12.2km)	>*80 to 36* *	>80 to 33 ** 2c	>36 to 25 ** 2b
2		10000 to 20000 (Alandur to Puzhithivakkam elev 3.8 km)	>29 to 23 ** 4c	33 to 20 ** 4c	25 to <22 ** 2b
3		20000 to 30000 (CMBT to Alandur elev 14.1km)	24 to 18 ** 6c	19 to 15 *	21 to 19 *
Assumed Capacity per coach/bus			270	242	80

** Section 9.3, Life Cycle Cost Analysis of Five Urban Transport Systems, IUT (India), 2012.*

*** Section 9.4, Life Cycle Cost Analysis of Five Urban Transport Systems, IUT (India), 2012, 4c: 4 car set. Average speed: Metro 35kmph, LRT or BRT 25kmph; average station/stop spacing: Metro 1km, LRT or BRT 0.75km, headway: Metro or LRT 2.5minutes, BRT 0.60minutes*

244. The above tabular statement shows that BRT has significantly lower unit life cycle cost from Puzhithivakkam to Sholinganallur. LRT shows no significant advantage to Metro on other sections.

245. Road connectivity is not available along the project alignment to operate BRT between Alandur and Adambakkam; road right of way is not adequate between Adambakkam and Puzhithivakkam on Medavakkam Main Road. In terms of reduced air pollution, benefit of Metro on the project corridors is estimated in Chapter 5 of this report; BRT adds to ambient pollution in comparison to Metro.

246. Screening distance recommended for vibration induced by rubber tyred vehicles is 16 m against 67 m and 50 m respectively for rapid rail and light rail (Transit Noise and Vibration Impact Assessment, US FTA, May 2006): this indicates that exposure zone of BRT buses will be smaller than Metro.

247. Screening distance recommended for noise generated by bus on BRT is 70m against 233m and 116m respectively for rapid rail and light rail (Transit Noise and Vibration Impact Assessment, US FTA, May 2006): this indicates that noise exposure zone due to BRT buses will be smaller than Metro.

6.5 Alternatives of Alignment, Stations

248. In order to decrease cost for the same rate of capacity utilization, the metro line was changed from underground to elevated right of way from CMBT to Medavakkam Koot Road Station.

249. Balance C5 has been planned to provide connectivity between North Chennai and commercial / residential / industrial landuse in East and South Chennai via bus transport hub while providing interchange facilities with Metro corridors in Phase 1 and Phase 2 as well as suburban rail and MRTS.

7. PUBLIC CONSULTATIONS AND INFORMATION DISCLOSURE

7.1 Consultations

250. MDBs' policies require projects to carry out meaningful public consultation on an ongoing basis. Public consultation will: (i) begin early and carry on throughout the project cycle; (ii) provide timely disclosure of relevant information, understandable and accessible to people; (iii) ensure a free and un-intimidated atmosphere without coercion; (iv) ensure gender inclusiveness tailored to the needs of disadvantaged and vulnerable groups; and (v) enable the incorporation of all relevant views of affected people, and stakeholders into project decision making, mitigation measures, the sharing of development benefits and opportunities, and implementation issues.

251. Public consultation and participation are a continuous two way process, involving, promoting of public understanding of the processes and mechanisms through which developmental problems and needs are investigated and solved. The public consultation, as an integral part of environmental and social assessment process throughout the project preparation stage not only minimizes the risks and manages the expectation of the project but also abridges the gap between the community and the project formulators, which leads to timely completion of the project and making the project people friendly.

252. Public consultation/information is an integral part of the Chennai metro project cycle. Public consultations with the people of different sections of the society along the project alignment, shopkeepers, and influential persons of the project area were made. Potential vulnerable people like, squatters, encroachers, schedule caste, and other backward section of society were consulted to make them aware and identify adverse impacts of the project.

253. The consultation process started early in 2017. CMRL held extensive consultation with the local community to share information of potential impacts and mitigation measures etc.

7.2 Stakeholders Engagement

254. Key stakeholders at central, state, district and local level which have been and will be consulted as part of the consultation process are listed as below. The minutes are attached in Annexure 9.

- Ministry of Environment, Forests and Climate Change (MoEF&CC)
- Central Pollution Control Board
- Tamil Nadu State Pollution Control Board
- State Environmental Impact Assessment Authority
- Tamil Nadu Coastal Zone Management Authority
- State Traffic Police Department
- State Public Works Department (PWD)
- State Fisheries Department
- Airport Authority of India (AAI)
- Chennai Municipal Corporation
- Tamil Nadu State Department of Archaeology
- Central Ground Water Board
- District Forest Office
- Indian Meteorological Department
- Non-government organizations
- Women groups
- Shopkeepers associations

255. As a first step CMRL officers met with Principal Conservator of Forests and Head of Forest Force Tamil Nadu on 20th August 2020 and discussed diversion of Nanmangalam Reserve Forest land. He principally agreed and instructed his office to advise CMRL on the process of application for such diversion. Consultation with the Forest Range Officer in charge of Guindy National Park took place on 23rd October 2020 to seek the Range Officer's guidance on Guindy National Park's status.

256. CMRL consulted the Defense Estate Officer on 17th October 2020 regarding the alignment adjacent to the Madras War Cemetery. The alignment will use the Highways right of way, hence no NOC will be required. Similar consultation was conducted between CMRL and Airport Authority of India to clarify that no NOC will be required.

257. Regarding the construction in River Adyar and Adambakkam Lake, the Fisheries Department was consulted on 22nd October and confirmed no fishing activities or fishermen in the nearby vicinity. The water conditions are tested and found not congenial for promotion of aqua culture. In October 2020, PWD reviewed the pier locations and arrangement though meetings and site visits, and found it to be satisfactory.

258. The construction along the Mount Poonamallee High Road is close to AAI transmitting station, with the nearest viaduct of 13 m from the boundary and station of 150m away from AAI property. AAI was shared with the alignment drawings. The requirement of NOC would be reconfirmed through their review on the detailed alignment and cross section near AAI.

7.3 Public Consultations

259. In order to enhance public understanding about the project and address the concerns of the community pertaining to mitigation of adverse impacts due to the Corridor 5, meetings with groups of persons comprising likely PAPs and other stakeholders in the community were conducted during the field survey that was carried out as part of detailed project report. These consultations are summarized in Table 7.1.

Table 7.1: Summary of Public Consultations Part 1

Location	Date	Number of participants	Suggestion/Opinion
Sholinganallur	27.10.2017	17	The shops should not be affected due to the proposed Metro project. The respondents said that this is an IT corridor and lots of traffic can be seen in the evening after office. So the metro project would be helpful.

Source: Comprehensive DPR for Chennai Metro Phase II, December 2018

260. During March / April 2019 public consultations with 37 participants were conducted at 8 locations. Public consultations and discussions were conducted with likely Project Affected Person (PAPs) as well as general public at identified station locations. The locations where selected so as to cover various socio economic profiles and habitation as well as impacted locations along the corridor. The consultation process involved various sections of affected persons such as traders, women, quarters, kiosks and other inhabitants. In order to hear and address the concerns of women, women were encouraged to participate and opportunity to express their concern was provided during the consultations.

261. During public consultation, benefits due the project and issues related to construction and operation were discussed with the affected communities; their opinions, suggestions and apprehensions were recorded. The consultations are summarized in Table 7.2.

Table 7.2 Summary of Public Consultations Part 2

Place	Date	Number of participants	Issue	Suggestion/opinion
Adambakkam	04.03.2019	4	Easy Travelling	Solve traffic issues and increase no of trips
			Fare	Fare should be comparable
Puzhuthivakkam	04.03.2019	8	Solve traffic issues and increase connectivity	Metro will reduce the traffic jam. The long distance travel will be easy and metro will increase the connectivity.
			Business loss due to construction activity	If construction activities go long more than expected, then it incurred loss to commercial/ shops.
			High ticket cost	The minimum metro ticket price in Chennai metro is Rs.50. The poor and middle class citizens will not be able to afford that money on a regular basis. So, they are using the bus services mostly.
Madipakkam	05.03.2019	5	Time Saving	Time will be saved in comparison with other means of transport.
			Traffic and pollution during construction of the project	There is a possibility of pollution and traffic problem during construction of the metro project.
			Reduction of road pollution	Metro train will reduce the existing high level of pollution both noise and air.
			Fare	Costly ticket of metro , Need to consider
Medavakkam Koot Road	27.03.2019	6	Road congestion	Operation of metro to reduce congestion on road
			Fare	Metro should be less expensive
			Reduction in pollution	Metro will reduce the existing traffic load and

				reduce the level of pollution.
			Metro reduce road side accidents	Metro will reduce the traffic and reduced in road accidents.
Perumpakkam	27.09.2019	5	Travel time	Travel time by metro will be lesser
			Congestion and Pollution	Congestion and Pollution due to road traffic will reduce
Global Hospital	04.04.2019	8	Reduction in Pollution	Metro will reduce the traffic and road accidents.
			Travel time	Travel time by metro will be lesser
			Area development	Due to metro train, other facilities will come such as infrastructure development. Local economy will boost up.
Sholinganallur	04.04.2019	6	Time Save	The metro train facility in Chennai will save time to reach the destinations in comparison with other means.
			Comfortable Travel	It would be easy to reach to the destinations due to the proposed metro project.
			Better connectivity	Metro may improve connectivity with speedy travelling.
			Reduction in pollution and accidents on road and overall	There would be reduced pollution and no accidents while travelling in metro train
			Fare	The metro fare should be as less as possible considering paying power of the people
Velachery	05/04/2019	7	Solve traffic issues and increase connectivity	Metro will reduce the traffic jam. The long distance travel will be easy and metro will increase the connectivity.
			Business loss due to construction activity	If construction activities go long more than expected, then it incurred loss to commercial/ shops.
			High ticket cost	The minimum metro ticket price in Chennai

				metro is Rs.50. The poor and middle class citizens will not be able to afford that money on a regular basis. So, they are using the bus services mostly.

262. The participants highly appreciated the upcoming phase- 2 metro projects as it will increase connectivity, reduce the traffic load and reduce existing level of pollution.

263. During December 2019 CMRL invited all citizens whose properties could be adversely affected by the project to apprise them of efforts to reduce property acquisition by optimising the project design.

264. Public consultations during construction and operation will form part of semi-annual monitoring reports sent by CMRL to MDBs. These consultations will focus on the impact mitigation measures being implemented and their efficacy.

7.4 Information Disclosure

265. Information disclosure will follow the procedure and disclosure requirements of MDBs' policies for category A projects.

266. All environmental documents are subject to public disclosure, and therefore, will be made available to the public. This EIA and the Executive Summary (in both English and Tamil) will be disclosed on CMRL and MDBs' websites. The hard copies of EIA will be made available at CMRL office as well as at other locations accessible to stakeholders. CMRL will ensure that meaningful public consultations, particularly with project affected persons' are undertaken throughout the design, construction and operation stages.

8. GRIEVANCE REDRESS MECHANISM

267. Grievance Redress Mechanism (GRM) is an integral and important mechanism for addressing/resolving the concern and grievances in a transparent and swift manner. Grievances related to the implementation of the project, particularly regarding the environmental management plan, rehabilitation and resettlement, compensation etc. will be acknowledged, evaluated, and responded to the complainant with corrective action proposed using understandable and transparent processes that are gender responsive, culturally appropriate, and readily accessible to all segments of the affected people. Records of grievances received, corrective actions taken, and their outcomes will be properly maintained and form part of the quarterly environmental monitoring report to MDBs.

268. Many minor concerns of peoples are addressed during public consultation process initiated at the beginning of the project. However the most common reason for delay in implementation of projects in urban areas is grievances of people losing their land and residential and commercial structures. Resolving such cases in the Court of Law will be a very time consuming process. Considering this and based on CMRL's past experiences of dealing with PAP grievances, a GRM has already been put in place in order to address the grievances of project affected persons. Such a redress mechanism available at the project level itself will mean that the complainants do not necessarily have to directly approach a Court of Law although availability of Grievance Redress Committee (GRC) mechanism will not bar them from doing so.

269. GRM will be in two layers: a) executing engineer from PIU and b) Grievance Redressal Committee (GRC). The first level of interaction of GRM with the stakeholders will be the executing engineers from PIU to resolve ground level grievances including construction nuisances to PAPs with support from contractor GRM focal. Issues should be resolved within 14 days. Those that cannot be resolved by PIU will be escalated to be examined by the GRC. Alternately complainants aggrieved by inadequacy of actions taken by the executing engineer can escalate to the GRC.

270. The Environmental Health and Safety Expert on the CMRL Project Implementation Unit (PIU) who is an environmental engineer will coordinate the GRC which will report to MD, CMRL and Director Projects, CMRL. The other members of the GRC will be,

- CMRL Project Manager of the package/section
- EMP implementation teams from CMRL and GC
- EMP Manager from construction contractor
- Assisting NGO
- PAPs and representatives
- With a view to Affirmative Action to enhance women inclusivity, one-woman representative of local community from each 5km section of the alignment will be members of the Environmental and Social Grievance Redressal Committee. The representative(s) from the location(s) to which the grievance(s) pertain(s) shall be invited to deliberations of the Committee.

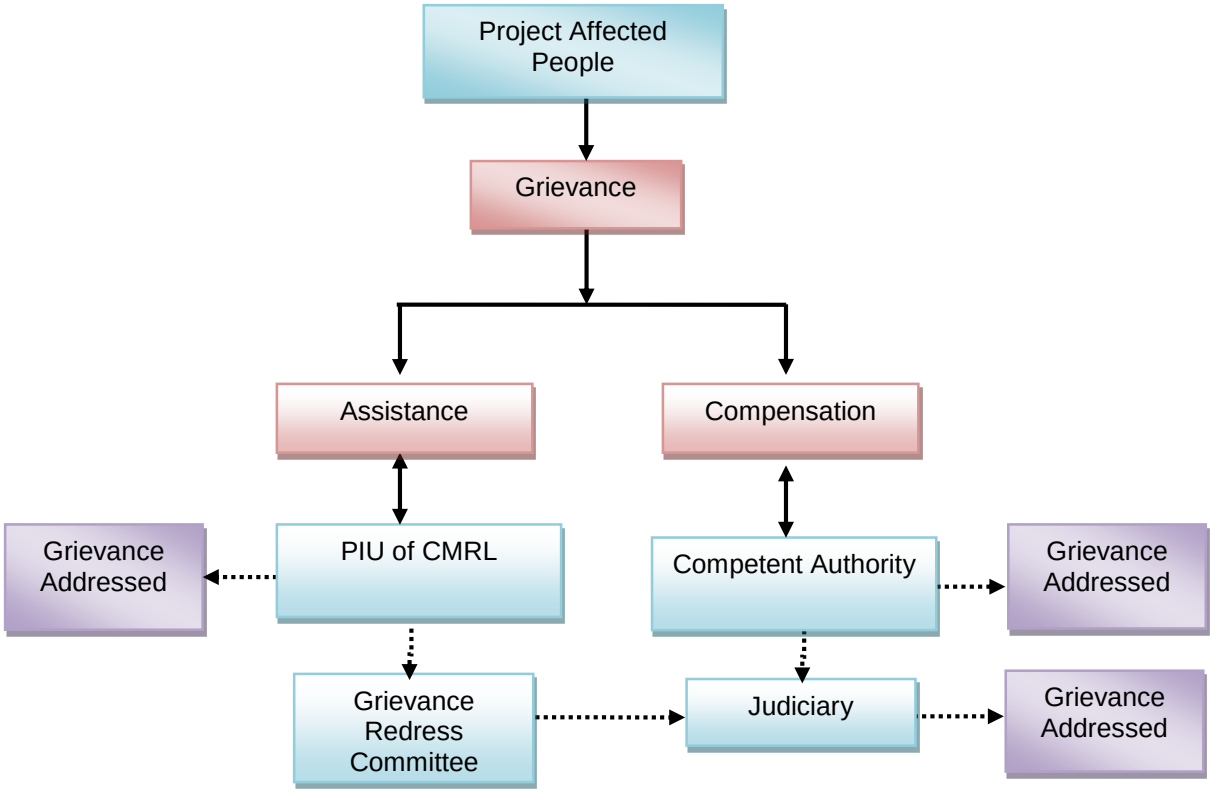
271. Records of the following stages will be maintained on website of CMRL throughout the life of the project:

- Complaints received
- Acknowledgement of receipt of complaint by executing engineer PIU
- Actions taken by executing engineer and their efficacy
- Escalation by executing engineer or by aggrieved parties
- Records of further action and closure of complaints.

272. Complaints and escalation by aggrieved parties can be done by paper mode as well as through email. The GRC will deliberate upon time limits for each of the above stages; the time limits will be placed on website of CMRL.

273. The flow chart of GRM is presented in Figure 8.1.

Figure 8.1: Grievance Redress Mechanism



274. The following process is followed for consideration of various cases by GRC:

- GRC function independently
- All grievances are received in written form by GRCs and a separate record of the same, including contact details, is maintained
- A separate file / processing document is created for each case, based on its category (project, location etc.) and all observations and documents related to the case are maintained in such file
- Cases related to environment pollution, noise, eligibility, entitlements, disputes etc. are promptly handled after consultation with relevant authorities
- GRCs can seek necessary record / information (such as survey details, past written communication etc.)
- Written notices are sent to the aggrieved persons and respondents to appear for hearing along with documents, and further dates are provided in case of genuine inconvenience to the party about the appointed date
- Multiple hearings are conducted as per the requirements of cases and aggrieved persons (including their representatives) and respondents are heard and are provided opportunities to submit further documents / proofs
- Site visit documents submitted by the parties are verified from appropriate sources, as may be considered necessary

- In normal circumstances (excluding those requiring information from external agencies) the entire process is carried out in a time bound manner (On an average, it takes about 1-2 months for disposal of each case in GRC)
- After due consideration of the cases, written and reasoned orders are passed under the signature of Head of concerned GRC
- Any fatality accident should be reported to GRC and MDBs immediately

275. In addition to the above GRM for addressing complaints from the local community, a separate GRM will be constituted for addressing the issues of the workers, forming part of the bidding document for CMRL to review and clear. The clauses in the tender include the following:

- Enquiries, complaints and requests for information can be expected from a wide range of individuals and organisations both private and government. The majority of complaints is likely to be received by CMRL, although the site offices are also likely to be contacted.
- The objective of complaint process is to ensure that public and agency complaints are addressed and resolved consistently and expeditiously.
- The Contractor's Project Manager will be notified immediately on receipt of complaint that may relate to environmental impacts. The Project Manager will immediately inform the Employer's Representative.
- Field investigation should determine whether the complaint has merit, and if so action should be taken to address the impact.
- The outcome of the investigation and the action taken shall be documented on a complaint Performa prepared by the Contractor and submitted for notice by the Employer's Representative in advance of the works.
- Where possible, a formal response to each complaint received shall be prepared by the Contractor within seven days in order to notify the concerned person(s) that action has been taken.
- Grievance log should be prepared and documented in the monitoring report with the resolution details.
- GRM for workers shall be established as early as possible to function no later than construction commencement.
- The GRM information and focal should be disseminated to public.

9. ENVIRONMENTAL MANAGEMENT PLAN

9.1 Introduction

276. The Environmental Management Plan (EMP) consists of a set of mitigation, monitoring and institutional measures to be taken for Balance C5 to avoid, minimize and mitigate adverse environmental and social impacts and enhance positive impacts. The plan also includes the actions needed for the implementation of these measures. The major components of the EMP are:

- Mitigation of potentially adverse impacts;
- Environmental monitoring;
- Emergency response procedures;
- Institutional arrangements and reporting mechanism;
- Implementation Schedule;
- Training and capacity building, and
- Cost estimates.

9.2 Objectives of Environmental Management Plan

277. The main objectives of this EMP are:

- To ensure compliance with MDBs' applicable policies, and regulatory requirements of GoTN and GoI;
- To formulate avoidance, mitigation measures for anticipated adverse environmental impacts during construction and operation, and ensure that socially acceptable, environmentally sound, sustainable and good practices are adopted; and
- To stipulate monitoring and institutional requirements for ensuring safeguard compliance.

9.3 Institutional Arrangement

9.3.1 Executing Agency

278. GoTN created a Special Purpose Vehicle (SPV) for implementing the Chennai Metro Rail Project. This SPV named as "Chennai Metro Rail Limited" was incorporated on December 03, 2007 under the Companies Act. It has now been converted into a Joint Venture of GoI and GoTN with equal equity holding. GoTN and GoI will be the Executing Agency of the proposed MDB Corridor 5-CMRL (Phase-II).

9.3.2 Implementing Agency

279. CMRL will be the Implementing Agency responsible for implementation of the metro rail project. Managing Director, CMRL will be in charge of the overall project activities. CMRL will be accountable to the GoTN (i.e. the EA).

280. Project Implementation Unit (PIU), CMRL headed by the Project Director (PD) is responsible for the overall execution of the project and implementation of the RP. The PIU will be assisted by General Consultant (GC). The safeguard role of GC is to assist CMRL in review of documentation and monitoring of implementation of EMP and monitoring plan during construction and operation by means of scheduled inspections, meetings and reports submitted to CMRL. The terms of reference are attached as Annexure 5.

9.3.3 Implementation of EMP

281. CMRL: EMP will be committed by CMRL as part of its agreement with MDB. The responsibility to implement the EMP including Grievance Redressal rests with CMRL. Environment clearances related to locations and design of the project will be secured before start of construction. Permissions/certifications required during operation of the project. Environment monitoring during operation.

282. Contractor: Permits required during construction and those directly related to construction. The EMP will be implemented by the contractors of different packages based on the contract agreement. The contractor SH&E team will be headed by senior Manager assisted by qualified and trained safety professionals and environment engineers along with onsite junior field personnel. This team will be assisted by:

- electrical and mechanical engineers qualified in safety evaluation;
- environment engineer;
- traffic engineer;
- professionals in occupational health and labour welfare.
- Environment monitoring during construction
- Regular monthly reports on implementation will be submitted by contractor to GC.

283. The Employer Requirements for Health, Safety and Environment have been prepared for Corridor 5; they will be issued to the Contractor as part of the contract documentation for construction. The requirements comprise the following 3 documents.

- Volume 1. Control Document
- Volume 2. Health and Safety Manual
- Volume 3. Environmental Management Arrangements

284. CMRL and GC: Supervision and review of implementation will be the responsibility of GC. With assistance from GC, CMRL will review and approve specific documents/plans that have to be submitted by contractors (traffic management plan, waste management plan, muck disposal plan etc.). Each MDB project will be monitored by a separate GC: project-wise teams from CMRL will work with the project-wise GC**.** Implementation of EMP will be continuously monitored by the Safety, Health and Environment (SH&E) team of environment experts from the GC and CMRL. Contractor's Safety, Health and Environmental Officer (SHEO) will engage GC-Environment Specialist to discuss EMP, seek clarification and recommend corresponding revisions if necessary; will agree with GC the monthly monitoring template and deadlines for submission; will submit for GC's approval a work plan to secure all permits and approvals needed to be secured during construction; will submit for GC's approval the construction camp layout and management plan before its establishment; will update EIA (in consultation with GC, in case of design changes) and also prepare site-specific EMPs.

285. The CMRL core environment team will be responsible for all corridors: it will be supported during construction by 2 junior CMRL environmental engineers who are assigned and charged to each corridor, assisted by safety, environmental, traffic, labour welfare professionals deployed by GC. During operation of metro, the core team will continue to monitor implementation of EMP by the metro operations contractors and EMoP by external environment monitoring agencies.

286. GC will contribute,

- Specialists from fields of safety, environment, traffic engineering, occupational and community health, ecology, noise and vibration
- Onsite junior field personnel.
- The visits and review meetings will comprise:
- Weekly site visits independently by CMRL and jointly with contractor;
- Weekly review meetings by CMRL and contractor.
- Periodic quarterly reports will be submitted on implementation of EMP and its internal monitoring by CMRL to MDB.
- Orientation and training of CMRL team in implementation of EMP and environmental monitoring will be undertaken at the beginning of the project.

287. MDBs: Implementation of the EMP will be monitored half yearly by MDBs through their experts.

288. External Monitor: An external agency will be engaged by CMRL in consultation with MDBs to evaluate the environmental performance of abovementioned parties. The agency will report to CMRL who in turn report it to MDBs. Separate External Monitor will be engaged for MDB Corridor 5. The terms of reference are attached as Annexure 6.

- To conduct third party monitoring of environmental compliance under the project;
- To ensure that the Project will be implemented in conformity with the policies of GoI, GoTN, as well as MDBs' policies;
- To Identify any safeguard related implementation issues and necessary corrective actions and reflect these in a time-bound corrective action plan for CMRL to implement;
- Capturing social, environmental and economic benefits and particular potential benefits to the poor and vulnerable groups in the corridor;
- Involving users and stakeholders in the monitoring process; and
- Strengthening the capacity of the CMRL to manage and replicate third-party monitoring with rail users and stakeholders.

289. The reporting line of all relevant parties is, Contractor PIU CMRL and GC MDBs. The external monitor will conduct independent monitor to inform CMRL any remediation actions to ensure the safeguard compliance.

290. An EMP Matrix is presented in Table 9.2.

9.4 Environmental Monitoring and Reporting Program

291. Environmental Monitoring Plan (EMoP) is a companion document of the EMP. EMoP contain parameters, location, sampling and analysis methods, frequency, and compared to standards or agreed actions that will indicate non-compliances and trigger necessary corrective actions. More specifically, the objectives of the EMoP are:

- Ensure that impacts do not exceed the established legal standards
- Check the implementation of mitigation measures in the manner described in the EIA report
- Monitor implementation of the EMP
- Provide an early warning of potential environmental damage
- Check whether the proposed mitigation measures have been achieved the intended results, and or/ other environmental impacts occurred

292. The monitoring plan will be used for performance monitoring of the project. A monitoring plan defining all parameters to be monitored, with tentative location, project

stages for measurements, implementation and institutional responsibility for different environmental components is prepared for all stages of project and presented in Table 9.3.

293. Monitoring and Reporting Frequency for implementation of the EMP is shown in Table 9.1.

Table 9.1: Monitoring and Reporting for EMP and EMoP

Particulars	Frequency of reporting	Reporting by / Reporting to	Review by/ Monitoring by
Starting from deployment of construction contractor from site selection period a) Implementation of EMP and EMoP b) Monitoring of implementation of EMP and EMoP c) Grievance Redressal	Monthly till completion of construction	a) Contractor / GC b) GC / CMRL SH&E team, CMRL SH&E team/MD, CMRL c) CMRL SH&E team/MD, CMRL	CMRL
a) Implementation of EMP, EMoP and Grievance Redressal and their internal (CMRL) monitoring b) Outcome of continuing public consultations	Bi-annually till completion of construction	All by CMRL / MDBs	• MDBs • TNPCB
Evaluate implementation and internal monitoring of EMP, EMoP, Grievance Redressal and their efficacy	Semiannually during construction	External Expert / CMRL	MDBs
a) Implementation of EMP by CMRL and EMoP by external agency b) Monitoring of EMoP c) Grievance Redressal	Semiannually during first 2 years of operation & maintenance	a) and b) • EMoP Agency / GC • GC / CMRL SH&E team • CMRL SH&E team/MD, CMRL c) CMRL SH&E team/MD, CMRL	CMRL
a) Implementation of EMP, EMoP and Grievance Redressal and Internal (CMRL) monitoring b) Outcome of continuing public consultations	Semiannually during first 2 years of operation & maintenance	CMRL / MDBs	• MDBs • TNPCB

Evaluate implementation and EMP, EMoP, Grievance Redressal and their efficacy	Annually during first 2 years of operation & maintenance	External Expert / CMRL	MDBs

Table 9.2: Environmental Management Plan Matrix

294. This EMP Matrix will form part of the contract document together with CMRL's SHE Manual for all contractors. This EMP has been aligned with the SHE Manual wherever possible, and in places, cross referencing has been resorted to.

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
Planning and Design Phase						
1.	Land Acquisition	Social	As per CMRL estimate of April 2020, permanent acquisition of 6.05 ha private land is required affecting 811 families. The final size of land to acquired will be updated based on the optimization of project design.	1. Compensation and Resettlement benefits as well as livelihood restoration measures have been approved by CMRL. based on The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. 2. Land Acquisition is being carried out as per the provision of GoTN and GoI policies. The affected people will be compensated and assisted as per the provisions of Resettlement Action Plan (RAP).	CMRL	Revenue Dept. GoTN
2.	Change in Land use	Land	Land use will be slightly changed	1. CMRL developed the Comprehensive Mobility Plan for CMA in 2015 to identify the present and future mobility patterns of Chennai Metropolitan Area, including development of Corridor 5. 2. Proper clearance/permission/consents will be sought from competent authority before construction.	CMRL	CMDA
3.	Contractor Management	EHS	EHS accidents Reputational Risk	1. Integration of EHS contractor management into broader project management, procurement, human resources, legal, and financial management. 2. "Prevention through design": assessment of what prime contractor does versus what subcontractors do; contractor prequalification (when, if, and for what); use of information technology tools (identification cards and tracking and reporting systems for personnel and training). 3. Prime contractor will be responsible for EHS practices of the subcontractor including human resource policy which complies with applicable labour legislations, including	Contractor / GC	CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				decisions on material supplies and equipment given environmentally friendly priorities, and prepare subcontract agreements accordingly. 4. Contractor management incorporates "adaptive management" to monitor and adapt over time; integration with sustainable procurement approach or concepts. 5. Building culture and commitment by demonstrating the importance of EHS management to the president or director of project-implementing agency and president or director of subcontractor; including EHS aspects in routine senior management project contractor meetings and reports, reflecting both criticisms or suggestions and praise; designating responsibilities of EHS staff (for example, work stoppage); requiring strong and consistent training and participation of managers; acknowledging managers' participation in on-site supervision and resolution of issues; and providing awards, recognition, and incentives. 6. Training and quality control plans.		
4.	Contractor Preparatory Works (Upon issuance of Notice to Proceed)	EHS	Non-compliance with contract conditions and regulatory requirements.	1. The Contractor shall complete the following activities no later than 30 days upon issuance of Notice to proceed, (a) appoint contractor's Safety, Health and Environmental Officer (SHEO); (b) SHEO will engage GC-Environment Specialist to discuss EMP, seek clarification and recommend corresponding revisions if necessary; (c) SHEO will agree with GC the monthly monitoring template and deadlines for submission; (d) SHEO will submit for GC's approval an work plan to secure all permits and approvals needed to be secured during construction stage which include but not limited to: i) operation of crushers and hot mix plants, ii) transport and storage of hazardous materials (e.g. fuel, lubricants, explosives), iii) waste disposal sites and disposal management plan, iv) temporary storage location, iv)	Contractor / GC	CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				water use, and v) emission compliance of all vehicles. Arrangements to link with government health programs on hygiene, sanitation, and prevention of communicable diseases will also be included in the action plan; (e) SHEO will submit for GC's approval of the construction camp layout and management plan before its establishment; and(f) SHEO will update EIA (in consultation with GC, in case of design changes) and also prepare site-specific EMPs. Template of internal weekly environmental inspection, weekly audit by the contractor are placed in Appendix II of Environment Social Health and Safety Requirements which form part of the construction contract documents; template for monthly audit by GC is at Appendix II. Contractor will submit monthly Environmental Quality Reports to CMRL; GC shall submit quarterly monitoring reports to CMRL.		
5.	Labour Management	Labour	Labour right	1. Compliance with GoI labor legislation, ratified International Labour Organization conventions. 2. Prohibition of child labor, including prohibition of persons under 18 years old from working in hazardous conditions (which includes construction activities) and from working at night; medical examinations required to determine that persons above 18 years old are fit to work. 3. Elimination of discrimination with respect to employment and occupation, to be defined as any distinction, exclusion, or preference based on race, gender, religion, political opinion, trade union affiliation, national extraction, or social origin. 4. Human resource policy or plans that establish (a) the rights and responsibilities of project company employees and any contractor employee working in the project regarding remuneration, working conditions, benefits, disciplinary and termination procedures, occupational safety and health, promotion procedures, and training	Contractor	GC / CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				and (b) the rights, responsibilities, and requirements in contractor or subcontractor agreements related to worker rights. 5. Grievance Redress Mechanism for workers should be established as early as possible to function no later than construction commencement. 6. There will be provision for group accidental insurance for the workers.		
		Health and Safety	Accidents and COVID-19	1. Make mandatory the use of safety gears (helmets, safety belts, masks, gloves, Ear plugs/ muffs and boot) by workers depending on nature of work. 2. Necessary planning and safety approach will be made for rescue during emergency. 3. Use of exhaust ventilation for dust control 4. Workers will be provided with first aid and health facilities at the site. 5. There should have facility to deal with medical aspects of HIV/AIDS treatment with specialized services. 6. CMRL COVID-19 protocols forming part of the Environmental Social Health and Safety Requirements contained in the contract document shall be followed: labour shall be trained and informed of precautions such as social distancing, sanitizing, avoiding groups; arrangements for thermal scanners; provision of sanitisers, face masks, gloves etc.; site record of COVID-19 hospitals; protected ambulances at site; daily disinfection of site, equipment and vehicles.	Contractor	GC / CMRL
6.	Obtaining Clearance, Permission and Consents	Regulatory Compliance	Delay of obtaining forest clearance, Tree felling information, Consents to establish labour camps, pre-casting and material yards, depots, establish and operate hot mix plant, crushers,	1. Consultation and coordination with relevant authorities to prepare the documents to obtain clearance, permission and consents. 2. Conditions set in the forest clearance, permission and consents to be incorporated into the site-specific EMPs, with dedicated officers to maintain the regulatory compliance tracker.	CMRL / Contractor	Tamil Nadu Forest Dept., / TNSPCB

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
			batching plant, DG sets etc. muck/waste disposal.			
7.	Site Clearance and Demolition	Tree felling	About 305 trees will be affected at alignments, & stations. This number will be updated again during site clearance. Additionally, in some areas, pruning will be required.	1. CMRL and Contractor need to conduct a final tree inventory survey (number, type, height) with the final designs of alignment and station. Trees with conservation value should be transplanted. Plan to avoid cutting patrimonial trees, including adjustments in project design to minimize effect on such trees. 2. Revisit the works in public parks or green spaces and potential tree removal, especially involving patrimonial trees of special significance, so minimize the impacts as much as possible. 3. If unavoidable, implementation of acceptable plans for transplanting (to the extent technically and economically viable) or replacing such trees and for their short-term maintenance and care. 4. Adequate coordination with applicable government regulatory authorities. As alignment passes through built land use, green belt development along elevated section is not feasible. Compensatory plantation of 12 saplings for every tree felled will be done in sites to be identified. CMRL to allocate sufficient tree replantation budget. 5. Plan including sites for compensatory plantation and species and identification of trees to be transplanted will be identified by CMRL in consultation with Forest Department and CMDA and Municipal Corporation. 6. CMRL Stakeholder communication to avoid or minimize public concerns or protests. 7. Definition of adequate budget and contingencies as well as financial resources to cover all related costs. This will	CMRL / Contractor	Forest Dept. GoTN and CMDA, GCMC

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				be finalized before work on relevant section is commenced between CMRL and Contractor.		
		Forest land	Landuse change from forest to non-forest purpose	1. Diversion of 7,570 sqm scrub forest land will be alienated upon payment of amount as per Forest Land Rules to the TNFD. Notwithstanding non-transfer of ownership, possession charges will be paid as per FC Rules. Normally, compensatory afforestation is to be raised on suitable non-forest land, equivalent to the area proposed for diversion, at the cost to be paid by User Agency. However it will be raised and maintained on degraded forest land twice in extent of the forest area diverted as this is a case of projects implemented by the Central Government/PSUs. As such, compensatory afforestation will be done on 15,140 sqm of degraded parts of Nanmangalam Reserved Forest. Such use of degraded forest land will obviate the need for transfer and mutation of non-forest/ revenue forest land in favour of TNFD. 2. Allocation of adequate budget to support the 1:12 compensatory plantation. 3. Additional measures will be taken to transplant the mature and ecologically important trees.	CMRL	GoTN Revenue and Forest Departments
		Avifauna Habitats and biodiversity in Nanmangalam Reserve forest and Pallikara	Disturbance to nesting and breeding due to noise and other project activities	1. Engage an ornithologist to conduct survey of breeding sites and review the populations of avifauna which may trigger critical habitats. 2. Avifauna habitats and breeding areas avoided as far as possible from project footprints. 3. Before the felling of trees, the trees will be inspected for presence of nests. If any trees have nests, the nests will be transferred to another nearby tree. This activity of transferring the nests will be done under the guidance of the local forestry or wildlife authority. The contractor will be prohibited from killing or hunting animals or birds in the project area.	Contractor	GC / CMRL /TNFD

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		nai marsh[1]		4. Assessment of actual and potential disturbance effects of project activities and develop the Biodiversity Management Plan (BMP) to ensure no net loss of the target species. The BMP will outline the actions required by the contractor to conserve or enhance biodiversity during site works particularly during piling and construction work. The BMP will be reviewed by lenders prior to contractor's mobilization. 5. Utmost care shall be taken to ensure that no disturbance/damage is caused to the Forest land and Marsh. For instance, use of noise barriers on the elevated line; lighting at stations on this section will be kept to the minimum and of frequencies and brightness which do not affect bird behaviour. 6. Liaison with local government offices to increase awareness of habitat protection and reduce further encroachment problems.		
		Aquatic ecosystem in Adyar River and Adambakkam Lake	Disturbance to the aquatic ecosystem due to the Pier Construction (8 piers in Adyar river and 14 piers in Adambakkam Lake)	1. Fisheries Department confirmed that no fishing activity is carried out at the proposed locations. Engage with PWD and Fisheries Department to identify areas of high biodiversity value and/or areas used by aquatic life for feeding and breeding. 2. The timing of construction should consider seasonal factors such as breeding and growing seasons; timing of feeding and periods of reduced ecosystem resilience (e.g., after extreme weather events); and to minimize the risk of erosion. 3. The construction methods and equipment should be selected to minimize suspension of sediments, minimize	CMRL / GC/ Contractor	GC / CMRL/ PWD / Fishery Department

[1] Nanmangalam Reserve Forest is a natural habitat. Pallikaranai Marsh is a modified habitat. Both sites will be further studied before contractor's mobilization to examine the applicability of Critical Habitat. The project will run along the edge of the forest, and will run in parallel with the marshland, hence no significant impacts envisaged if the mitigations will be properly implemented. Furthermore, the forest land to be diverted is devoid of tree felling. The anticipated impacts on the avifauna habitats due to tree felling will be limited. The impacts on avifauna reproduction, nesting and breeding will be assessed during the ecological survey, in order to reflect the mitigation or offset measures in the BMP.

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				destruction of benthic habitat, minimize the noise and vibration. 4. The construction material and waste storage areas should be selected to avoid contamination of river water quality and to avoid disturbance on existing embankments. All wastes are to be removed from site and disposed of at an approved facility. All waste concrete and concrete wastewater must be collected and disposed of under the supervision of SHEO with records (logs and photos). 5. The primary water quality at construction site of Adyar River and Adambakkam Lake has been collected. During construction, the onsite monitor of water quality will be required. Contractor will compare the parameters with the background water quality. At a minimum, this will involve daily visual inspections; measurements of turbidity, pH, temperature, and conductivity. 6. Ensure the site isolation is monitored on a full-time basis. Inspection and monitoring (such as feedback or adaptive monitoring) of construction activities in Adyar River and Adambakkam Lake should be conducted timely to evaluate the impact of construction, the effectiveness of mitigation measures, and the need for technical adjustments to avoid and minimize impacts to identified sensitive aquatic receptors. The frequency of monitoring should be sufficient based on site specific considerations. 7. Ensure the aquatic habitat is restored to, or as close as possible to, its natural status upon construction completion. 8. Incorporate all the above mitigation measures and any other measures recommended by GC into the BMP for lenders to review prior to contractor's mobilization.		

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Noise	Noise will be generated the use of hand tools such as jackhammers, sledgehammers and picks etc.	1. The procedure of demolition will be conducted as per the demolition plan prepared by the Contractor in consultation with CMRL. 2. The existing structures should be demolished one after another cautiously. 3. Wherever possible demolition will be done manually	Contractor	GC / CMRL
		Physical Cultural Resources	Historic and Cultural Value Loss	1. Contractor to conduct pre-construction structural integrity inspections if there are known or a significant likelihood of archaeological and/or culturally valuable sites or finds in the project's direct area of influence. Prepare a monitoring scheme prior to construction based on the above inspections, with a focus on pre-identified receptors comprising educational, medical and physical cultural buildings located within recommended screening distance of 62m (for cat. 2) on either side of alignment , or finds in the project's direct area of impact.. 2. Prepare a monitoring scheme prior to construction based on the above inspections, with a focus on pre-identified culturally valuable sites if any near the alignment, or finds in the project's direct area of impact.. 3. Compliance with applicable legislation (permits and procedures) and good international practice. 4. Adaptive management in site-specific EMP during final design, including site locations (stations and construction staging areas). 5. Chance finds procedure to be prepared by Contractor and reviewed by GC/CMRL before submitting to all lenders. 6. Measures to mitigate noise and vibration are already listed in this EMP. Maximum levels of noise and vibration.	Contractor	GC / CMRL / CMDA
8.	Severance of utilities	Social EHS	The proposed alignments will cross drains and utility services such as sewer, storm water	1. Assets and utilities will be maintained without affecting and damages by shifting temporary/ permanently where it is necessary.	Contractor	CMRL / CMWSSB ,

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
			drains, water and wastewater pipes, roadside lights, telephone cables, electricity power lines, electric poles, natural gas lines and traffic signals etc.	2. Based on utility maps and network information, CMRL and Contractor in collaboration with utility owners oversees an investigation of existing utility supply infrastructure using trial pits or mix of 3D imaging and trial pits where pits pose safety hazards in built areas. CMRL and Contractor to conduct on-site inspections and a topographic survey. Even when utilities are far enough below the surface, to avoid damage from construction, they may need to be diverted so that their maintenance will not affect the safe and efficient operations of the train system once construction is completed. Utility owners will be involved in providing any new utilities needed for the rail system and in designing the necessary diversions and protection measures to minimize the risk to existing utilities from ground movement and surface settlement. 3. In case gas pipelines are found during detailed utility survey prior to construction, Contractor will conduct the hazardous operation study to ensure the smooth and safe shifting. 4. Utility shifting plan will be developed by CMRL and Contractor in coordination with concern authorities and shifting of utilities will be done as per agreed utility shifting plan prior to construction commenced. The plan will include required EHS management measures, supervision and monitoring of implementation, and final report and confirmation that construction works will be properly closed (for example, all waste will be removed or re-pavement will be completed as required). 5. In case public utilities are required to be shifted to private land in exceptional circumstances, then adequate compensation shall be made by CMRL to the property owner on the same principles as temporary land acquisition. Following completion of construction of metro, such utilities shall be rehabilitated on public land.		TANGEDCO, Telecom companies

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
9.	Noise and Vibration Impacts Related Design	Environmental Nuisance	Noise and vibration from construction and train operation	1. The detailed noise and vibration analysis (mathematical modeling) at pre-identified receptors comprising educational, medical and physical cultural buildings and other fragile buildings located within recommended screening distance of 62m (RRT, cat.2) for vibration and 100m (RRT, intervening buildings) for noise on either side of alignment based on final engineering designs is ongoing, based on which, a set of mitigations should be prepared and shared with all lenders for review, prior to commencement of construction. 2. Visual inspections of these buildings shall be done by the contractor so as to serve as baseline to monitor progression of building damage if any due to vibration. 3. Ballast less track structure is supported on two layers of rubber pads to reduce noise and vibrations. In addition, baffle wall as parapets will be constructed up to the rail level so as reduce sound levels. Noise at source will be controlled or reduced by incorporating suitable feature in the design of structures and layout of machines and by use of resilient mounting and dampers etc. 4. Noise barriers made of suitable polycarbonate as per tender document will be installed.	Contractor	GC / CMRL
10.	Lighting	Bird Habitat	Impact on bird habitats and nocturnal animals	1. Lighting on viaduct and stations from Velakallu to Medavakkam Koot Road Bus Stop station, Perumbakkam to Ok. Tho stations will be kept at frequencies and brightness which do not affect bird and wildlife behavior.	Contractor	GC / CMRL
11.	Coordinate with the Traffic Department on Traffic Management Plan	Land Occupational safety Community safety	Nuisance from traffic congestion	1. The Contractor shall develop detailed and robust traffic management plans consistent with the Indian Guidelines on Traffic Management in work zones (Indian Road Congress:SP:55-2014), prior to mobilization for respective sections with site- or station-specific plans and	Contractor	GC/ CMRL/ Traffic Police

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				measures to minimize the overall impact on traffic throughout the construction and operation periods. 2. At congested sections, the temporary traffic coordinators will be engaged by CMRL to facilitate the traffic management. 3. At the minimum, the traffic management plans will have the following components: construction traffic, ensuring access to properties, accommodating pedestrians, parking, access by construction vehicles, faulty traffic lights and problem interchanges, use of public roads, parking provision during construction, use of residential streets and traffic diversion due to temporary road closures, and construction and use of temporary access roads. 4. Strengthening impact and risk prevention measures, such as establishing construction site works to minimize the entrance and exit of vehicles at stations during peak traffic. 5. The logistics should be considered to manage transport materials from storage areas outside of the dense urban core to worksites and to return excavated soil and other materials to disposal locations. If needed, construction traffic may be confined to certain routes (based on infrastructure capacity) or restricted to certain off -peak hours (that is, to reduce noise pollution at night or to avoid commuting and school hours during the day). 6. Any diversions of traffic will cause considerable confusion for pedestrians and drivers as they rearrange their itineraries, hence, to minimize the effects of the diversion or reorganization, it is necessary to conduct communication campaigns and disseminate appropriate information to urban residents and taxi and bus drivers in advance of disruptions. Efforts will be given to divert traffic to roads wide enough to accommodate extra traffic. Compliance with scheduled deadlines for the detour is		

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				essential. If necessary, bus service and other public and private transport services in the area should be improved to meet residents' transportation needs. 7. Incorporation of community safety considerations into plan design, especially at locations such as CMBT to Porur, St Thomas Mount to Velakallu, Medavakkam Koot road to Perumbakkam where buildings are close to the construction site. 8. In order to avoid risk to life and damage during construction near and above properties which are not proposed for permanent acquisition, such properties and premises shall be vacated and residents/users temporarily shifted for duration of construction. 9. CMRL and local authorities continue to play an oversight role in approving these plans during construction, evaluating their cumulative impact with other infrastructure projects in the region, and ensuring their dissemination to all relevant stakeholders.		
12.	Construction method, construction material and sites selection	Environment	Pollution and nuisance	1. Contractor is committed to use environmentally friendly construction methods and materials, including cement, sand and aggregate. 2. Construction material shall be sourced from quarries approved by GoTN and CMRL. Extraction from river beds is banned. 3. The contractor shall collect from his material vendor and submit to CMRL valid consents to establish and operate issued by TNSPCB for the quarries from where the vendor sources the material as well as the quarry licence issued by the concerned district authorities. This requirement applies equally to authorized vendor or new vendor.. 4. The contractor shall be responsible to ensure that the vendor adheres to the pollution mitigation measures during loading, transportation and unloading the material	Contractor	GC / CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				as contained in the construction contract documents Again this requirement applies equally to authorized vendor or new vendor. The contractor`s or CMRL`s responsibility shall not extend to verifying that the quarry operator is abiding by the stipulations of the quarrying licence and consents issued to him. 5. Energy saving technologies will be embedded into the Project design wherever possible. For instance, solar panels, rainwater harvesting. Bureau of Energy Efficiency (BEE) certified/ Energy efficient LED lights, automatic signaling, etc. 6. Update of plan based on final contractor-defined estimated volumes and timing for groundwater pumping with intension of minimizing the groundwater consumption. The primary objective shall be to avoid extraction of groundwater for construction. However use of groundwater which has been generated by dewatering of excavations can be used in construction activities. In those instances where extraction of groundwater becomes unavoidable, contractor shall, with consent of CMRL, resort to such extraction. In such instances contractor-defined estimated volumes and timing for groundwater pumping with intention of minimizing the groundwater consumption. 7. Procedures for minimizing waste segregation, reuse, temporary storage, recycling, donation, and disposal. 8. Selection of waste disposal service providers (transport, recycling, and disposal) based on EHS criteria (including compliance with all regulatory requirements, no documented EHS issues related to materials at operation or site facilities, and agreement to provide access for site visits to discuss EHS management). 9. Final selection of disposal or reuse sites for extracted soils from construction and assessment and		

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				determination of truck routes from project sites to disposal or reuse site. 10. Focus will be placed on reuse of the extracted soil for enhancement of green space, waste recycle, and storm water runoff. 11. Construction yards with aggregate crushing and screening, pre-casting, material and fuel storage and ready-mix concrete plants will be located away from inhabited or ecologically sensitive areas. Locations will be decided by CMRL and cleared by MDBs before construction commencement in consultation with Municipal Corporation/Municipalities and CMDA. 12. The muck disposal sites shall be identified by Contractor and will be decided by CMRL before start of construction in consultation with TNPCB, Municipal Corporation/Municipalities and CMDA, to ensure a safe distance from residential areas, water bodies and ecologically sensitive locations as to avoid disrupting natural drainage. The muck shall be filled in the dumping site in layers and compacted mechanically. Suitable slopes will be maintained on the stockpile. Once the filling is complete, it will be protected by low walls, provided with a layer of good earth on the top and covered with vegetation. A muck disposal plan will be prepared by Contractor and approved by CMRL and TNPCB. Hazardous waste will be taken away by licensed vendors who will be responsible for due disposal at permitted sites.		
13.	Climate Designs	Health and Safety	Natural disasters generated health and safety accidents Maintenance Cost	1. Disaster management plan will pay special attention to road drainage from Medavakkam to Ok. Tho, to adapt the disruption of road level access to stations due to rise in mean sea level.. 2. Other climate adaptation designs will be embedded in the final design, such as (a) Increase in capacity of	Contractor / GC	CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				stormwater drainage will be made so as to deal with extreme flooding in addition to demand of future landuse growth along this alignment.. Increased number of pits for rainwater harvesting from elevated metro to cater to flood waters and heavy rains. 3. Climate change mitigation measures will be considered, such as solar panels on station buildings and roofs to reduce the extensive use of grid-generated electricity supplied to the station for operation and maintenance.		
14.	Site-specific Environmental Baseline Collection and Assessment	Environment	Benchmark of assessing project impacts	1. Prior to mobilization, contractor to collect a full set of baseline data of air, water (surface and ground), noise, vibration, soil quality. Special attention to water quality of Adyar River and Adambakkam Lake. 2. Additional investigations in areas identified as having contaminated soil or groundwater to define the degree and extent of contamination and alternatives for soil and groundwater disposal. Assessment of potentially contaminated soil at site locations where soil work and excavations will be performed to examine the site situation. If there is a reasonable likelihood of contamination, then a specific management plan that includes (a) monitoring during construction consisting of visual inspections, on-site and in-situ monitoring to detect and confirm levels of contamination (and supplemented as needed by laboratory analysis), (b) on-site temporary storage and treatment, (c) final disposal (both for water and soil), and (d) worker health and safety procedures. 3. Assessment and site-specific measures for controlling noise, dust, and illumination during construction (for example, when working 24 hours a day). 4. Confirmation of potential uses of groundwater. Efforts on minimizing the groundwater consumption. 5. Contractor to prepare site-specific EMPs for CMRL to approve before mobilization.	Contractor	CMRL / GC

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				6. Based on detailed construction work plan and associated occupational health and safety risks, strengthening the contractor health and safety management system in site-specific EMPs. 7. CMRL and GC to provide EMP orientation to contractor.		
15.	Documents Review, Stakeholder Engagement and Information Disclosure	EHS	Unanticipated impacts management	1. With the assistance of GC, CMRL will review the above said data collections, surveys and pre-construction plans prepared by Contractor. 2. As part of stakeholder engagement activities, with the assistance of GC, CMRL will consult with all relevant governing authorities regarding the project impacts and mitigations, including but not limited to, Public Works Department, Fisheries Department, Tamil Nadu Forest Department (including potential impacts on Guindy National Park), Tamil Nadu Highways Department, Defense Estate office, Airport Authority of India, Southern Railways. All meetings shall be well documented. 3. CMRL will submit to all lenders to review the documents and disclose in a timely and meaningful manner prior to construction.	CMRL	CMRL
16.	Establishment of Grievance Redress Mechanism	EHS	Complaints not resolved in time	1. Grievance Redress Mechanism for workers and project affected people should be established as early as possible to function no later than ground work commencement. 2. The Grievance Redress Mechanism information and focal should be disseminated to public.	CMRL	GoTN
17.	Community Liaison	Social	Complaints	1. To ensure that Grievance Redress Mechanism to function effectively for affected people on construction nuisance at ground level with grievance log well documented. 2. Contractor to develop a community communication plan per the construction plan, including important measures	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				to reduce community risk, such as fence and related protection around work sites (including strength and visual protection), education and awareness signs and information, and placement of safety risks (explosive and flammable materials, generators).		
Construction Phase						
18.	Construction Monitoring	EHS	Breach of legislation, EIA, EMP, Contracts Accidents	1. Contractor to collect and monitor the Ambient environmental data of air, water (surface and ground), noise& vibration, soil quality and submit monitoring reports to GC / CMRL on monthly basis. 2. GC / CMRL to review the data compared to baseline data and urge Contractor to take immediate actions over any project generated pollution / contamination. 3. GC to submit monitoring reports on quarterly basis to CMRL. 4. If any unanticipated EHS impacts arise during construction, implementation or operation of the Project that were not considered in the EIA / EMP, Contractor and GC to promptly inform CMRL of the occurrence of such risks or impacts, with detailed description of the event and proposed corrective action plan. CMRL will report to all lenders accordingly. 5. CMRL to engage qualified and experienced third party monitor to verify information produced through the Project monitoring process, and facilitate the carrying out of any verification activities by such third party monitor. 6. CMRL to submit the semi-annual monitoring reports (GC's and third party's) using the agreed template to all lenders. 7. CMRL to report all lenders any actual or potential breach of compliance with the measures and requirements set forth in the EMP promptly after becoming aware of the breach.	Contractor / GC / CMRL	TNSPCB

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Biodiversity	Breach of legislation and BMP	1. Apart from the abovementioned measures for EHS monitoring, CMRL to ensure the BMP implementation monitoring and wildlife monitoring. If any wildlife species are found in the construction site, they will be carefully transferred to safe locations within the Forest Land or Marsh under the guidance of the biodiversity expert and the local forestry/wildlife agency. 2. Monitor construction (a) to avoid construction activities near critical habitats during migrant and breeding seasons; (b) Minimize construction activities near Nanmangalam forest and Pallikaranai Marsh during the bird migratory season to the extent possible. 3. Monitor noise level to minimize the impacts, for instance, use of rotary drilling rigs which generates less noise in comparison to impact hammer. The Construction Method Statement will follow the Good International Industry Practice. 4. Monitoring habitat enhancement to deliver net benefit to Critical Habitat species.	Contractor	TNFD /CMRL/ Fisheries Dept
19.	Community Liaison	Social	Complaints	1. To ensure that ongoing timely consultations / communications with communities are provided on the progress of the project together with feedbacks on the environmental management performance of the project. 2. Grievance Redress Mechanism for affected people should function effectively with grievance log well documented. 3. Contractor will provide a minimum of two (2) weeks notification to directly affected residents, businesses and other relevant groups of the intended construction commencement date. In providing a mechanism for communication between the contractor and the community and informing the public of construction details (timing, expected impacts), CMRL will undertake consultations.	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				4. Adaptive management that monitors, adjusts, or adds measures to reflect actual community risks. 5. Important measures to reduce community risk, such as fence and related protection around work sites (including strength and visual protection), education and awareness signs and information, and placement of safety risks (explosive and flammable materials, generators).		
20.	Truck and Driver Management	Environment Social	Community disruption Accidents Reputational risk	1. Contractor's transport vehicles and other equipment shall conform to emission standards. 2. Control, inspection, and documentation of trucks prior to leaving site, including removal of soil on tires. Contractor will provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt. 3. Definition of allowable routes, speeds, and times (day or week). 4. Driver requirements and controls, including prework medical (and blood tests) and physical inspections, ongoing monitoring (of visual and alcohol or drug use), driver training, daily total allowable work time, and allowable deviations. 5. Driver contracts with clearly specified requirements and remedies for noncompliance. 6. Use of electronic monitoring (GPS), driver training, and stops. 7. Procedure for truck maintenance, including selection of service providers considering environmental aspects, application of low-Sulphur fuel, no idling of trucks, routine maintenance (including assurance of proper engine operations related to emissions and noise), and disposal of used oil and other fluids, batteries, and tires etc.	Contractor	GC / CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				8. Used water shall be collected, subject to precipitation and re-used.		
21.	Leveling of Site	Land	Surface leveling will alter the soil texture and compactness, which will affect the infiltration and soil ecology. Also leveling will involve alteration of natural drainage	1. Interim drainage system will be installed prior to construction. 2. Where feasible, infiltration losses could be countered by installing Rainwater Harvesting pits away from construction site.	Contractor	GC/ CMRL
22.	Mechanical piling and Pier Construction	Air	Construction of Piles Piers will result into fugitive dust generation	1. Fugitive dust could be controlled using water sprinkling. Water sprinkling to be carried out by Contract at regular interval (to be mutually decided by the contractor and CMRL). 2. Every vehicle should be washed to remove any dusty materials from its body and wheels before leaving the construction sites. 3. Imposition of speed controls for vehicles on unpaved site roads. Ten kilometers per hour is the recommended limit.	Contractor	GC/ CMRL
		Noise	During mechanical piling operations, noise will be generated which may go up to 88-90 dB (A) at a distance of 5m	4. At sensitive locations, auger piling will be carried out in place of mechanical (by driven) piling which will generate less noise than mechanical piling (around 70-75 dB(A)). Also 2m high barricade of GI sheet will be installed on all sides of piling operations. This could effectively cut down noise levels by 10-15 dB (A). Piling operations will be restricted during day time hours only. 5. Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. 6. Use of low-noise equipment and ensuring good maintenance, and trying to avoid using high-noise equipment simultaneously at the same section. 7. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. If baseline noise is below the CPCB and IFC-EHS standards, the	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				construction noise has to meet these standards that is, construction noise level has to be less than level prescribed in these standards. 8. Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. 9. Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities. 10. Monitoring required during construction, including field observations and measurements.		
		Vibration	Pile driving for viaduct piers and buildings vibrations	1. Cast-in-situ piling will be deployed at locations with sensitive receptors so as to reduce vibration. 2. At locations where the alignment is close to sensitive receptors, the contractor shall implement the pre-construction structural integrity inspections. 3. Contractor to ensure that vibration levels at historically and culturally sensitive Structures, and Structures in poor state condition will not exceed 5.0 mm/s. 4. Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. 5. Monitoring during construction including field observations and measurements.	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Waste	Soil and surface/ground water pollution	1. Bentonite slurries used in construction should be reconditioned and reused wherever practicable. 2. The disposal of residual used bentonite slurry should follow the international good practice. 3. Segregation and storage of different types of waste in different containers, skips or stockpiles to enhance reuse or recycling of materials and their proper disposal. 4. Nomination of an approved person, such as a site manager, to be responsible for good site practices, arrangements for collection and effective disposal to an appropriate facility, of all wastes generated at the site.	Contractor	GC/ CMRL
		Aquatic Ecosystem	Construction of piers inside the Adyar River and Adambakkam Lake, marshlands near the waterbodies may result in release of construction materials (concrete, fuel, chemicals etc.) inside the water. Construction activities may also cause excessive siltation inside the river. These impacts will in-turn affect the fishes and other aquatic species, as well as water birds.	1. Construction of piers inside the waterbodies will be done in a caisson which will contain all the concrete and construction material resulting minimal release of construction material into the water. 2. Constructing the pier will be done by using rotary drilling rigs and no impact hammering. Rotary drilling rig generates far less noise and has negligible impacts on aquatic wildlife in comparison to impact piling which can startle fishes and damage their auditory organs. 3. Turbidity curtains will be used during pile driving activities if any to reduce the potential for increases in suspended sediment. 4. The contractor will be prohibited from fishing or other aquatic wildlife. 5. Construction works inside the Adyar River and Adambakkam Lake will be timed in dry season and will be kept at minimal during bird migrating, breeding and feeding season. 1. Construction in the waterbodies will be avoided during the rainy season to minimize construction duration inside the water.	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Physical Cultural Resources	Historic and Cultural Value Loss Conflicts with community	1. Before start of piling, Contractor and CMRL will coordinate with Tamil Nadu State Department of Archaeology to reconfirm that there is presence of buried artifacts along the metro line alignment. No piling will be allowed unless cleared by the Archaeological Department. 2. Archeological monitoring during construction stage, including specialists in field with authority to stop work. 3. All workers will undergo a briefing with the Archaeology Department to ensure safeguarding of heritage resource and cultural/religious practices. 4. A proof of compliance to this requirement to include the name of participants and date and location of briefing will form part of the monthly report to CMRL. 5. The project will implement, where required, chance finds procedure contained in ESS8 of WBG ESF. It includes requirement to notify relevant authorities; to fence-off the area of finds or sites to avoid further disturbance; to conduct an assessment of found objects or sites by cultural heritage experts; to identify and implement actions consistent with the requirements of this ESS and national law; and to train project personnel and project workers on chance find procedures	Contractor	GC/ CMRL /Archaeological Survey of India
		Health & Safety	Noise and vibration generated during piling will affect the health and safety of the workers	1. Auger piling methods will be used to reduce the impacts of noise. 2m tall screens of GI sheets will be installed between source (pile driver) and receptors (workers & nearby populations). 2. To reduce the harmful effects, personnel working at high noise levels would be provided with noise protective gears such as ear mufflers, sound barriers, job rotations per occupational exposure limits etc. 3. Oversight of project safety is needed to ensure proper support and lining of excavated sections to avoid collapse.	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				4. Where a site boundary adjoins a road, streets or other areas accessible to the public, hoarding should be provided along the entire length except for a site entrance or exit. 5. Procedure to receive, evaluate, and compensate (if applicable) damages due to construction and establishment of financial resources to cover this expense.		
23.	Excavation (The quantum of soil excavated soil will be about 1.44 lakh cubic meter)	Air	Excavation will result into fugitive dust generation.	1. Fugitive dust could be controlled using water sprinkling. Water sprinkling to be carried out by Contract at regular interval (to be mutually decided by the contractor and CMRL). Surface runoff, wastewater from construction sites, construction yards and seawater will be used. 2. Imposition of speed controls for vehicles on unpaved site roads. Ten kilometers per hour is the recommended limit. 3. Every vehicle should be washed to remove any dusty materials from its body and wheels before leaving the construction sites. 4. Excavation machinery will be topped up by low-Sulphur fuel. 5. Water for sprinkling and tire washing will be sourced from treated effluent from ETPs located nearby or seawater or surface runoff; use of municipal treated water shall be minimized. Groundwater will not be used.	Contractor	GC/ CMRL
		Noise and Vibration	Nuisance	1. Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. 2. Use of low-noise equipment and ensuring good maintenance, and trying to avoid using high-noise equipment simultaneously at the same section. 3. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. If baseline noise is below the CPCB and IFC-EHS standards, the	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
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				construction noise has to meet these standards that is, construction noise level has to be less than level prescribed in these standards. 4. Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. 5. Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities. 6. Monitoring required during construction, including field observations and measurements. 7. Contractor to ensure that vibration levels at receptors comprising educational, medical and physical cultural buildings and other fragile buildings located within recommended screening distance of 62m (for cat. 2) on either side of alignment will not exceed 5.0 mm/s.		
		Surface water	Dumping of construction waste like concrete, bricks, waste material etc. cause surface water pollution.	1. Proper drainage systems using contour information will be constructed around active and & large construction sites. The wastewater should be discharged after sedimentation in tanks. 2. To avoid water pollution and soil erosion due to flooding, earthwork will be limited during monsoon season.	Contractor	GC/ CMRL
		Groundwater	Dewatering (if done) will adversely affect the groundwater regime.	1. Dewatering due to piling will be small in quantity. It will be done only when required Groundwater will be collected in sedimentation tanks and reused in non-potable uses. Refer to SHE (Addendum to this EIA report). 2. As it is likely to be contaminated with chemicals on construction sites this water after precipitation, will be discharged into public sewers; it will be treated by municipal agencies to Environment Protection Rules	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				(EPR) 1986 Schedule VI standards of discharge of general effluents into surface water. 3. Groundwater monitoring, including groundwater quality and aquifer status.		
		Soil	Excavation will adversely affect the soil	1. Soil erosion by runoff will be controlled by installing proper drainage systems using contour information It is suggested to avoid bringing soil from outside the project boundary and to use the excavated mounds for filling low lying area where it is necessary. 2. The topsoil should be preserved (by storing it at appropriate places) so that same can be restored after completion of work.	Contractor	GC/ CMRL
		Physical Cultural Resources	Historic and cultural value loss Conflicts with community	1. Before start of excavation, Contractor and CMRL will coordinate with Tamil Nadu State Department of Archaeology to reconfirm that there is presence of buried artifacts along the metro line alignment. No excavation will be allowed unless cleared by the Archeological Department. 2. Archaeological monitoring during construction stage, including specialists in field with authority to stop work. 3. All workers will undergo a briefing with the Archaeology Department to ensure safeguarding of heritage resource and cultural/religious practices. 4. A proof of compliance to this requirement to include the name of participants and date and location of briefing will form part of the monthly report to CMRL. 5. The project will implement, where required, chance finds procedure contained in ESS8 of WBG ESF. It includes requirement to notify relevant authorities; to fence-off the area of finds or sites to avoid further disturbance; to conduct an assessment of found objects or sites by cultural heritage experts; to identify and implement actions consistent with the	Contractor	GC/ CMRL/ Archaeological Survey of India

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				requirements of this ESS and national law; and to train project personnel and project workers on chance find procedures.		
		Health and Safety	Accidents	1. To specify the number and length of shifts for each worker. 2. Where a site boundary adjoins roads, streets or other areas accessible to the public, hoarding should be provided along the entire length except for a site entrance or exit.	Contractor	GC/ CMRL
		Aesthetics	Loss of aesthetics value due to excavation and related activities.	1. The excavation sites will be barricaded on all sides using GI sheets. Hauling will be carried out in non-peak hours. 2. Aesthetic value of the site will be restored after completion of the works.	Contractor	GC/ CMRL
24.	Hauling of excavated material	Air	During transportation of excavated material, fugitive dust will be generated from two sources, (1) from re-suspension of dust from road surface, (2) from the movement of air, against the excavated material being hauled	1. The traffic management plan will be stringently implemented with regular monitoring and inspections. 2. The trucks/dumpers carrying the excavated material will be covered using tarpaulin/similar covering materials. 3. Sprinkling of water should be carried out. 4. Truck tires will be washed to excess remove soil clinging to it. Contractor will provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt. Used water shall be collected, subject to precipitation and re-used. 5. Water for sprinkling and tire washing will be sourced from surface runoff, wastewater from construction sites, construction yards and seawater; use of municipal treated water shall be minimized. Groundwater will not be used in view of status in Chennai. 6. Haul roads will be kept in good state of maintenance.	Contractor	GC/ CMRL/ TNSPCB/ Traffic Police

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Noise	Dumper trucks carrying excavated material will result into high noise (typically in excess of 85 dB (A) at one m distance, or 57 dB (A) at 10 m distance). The adverse impacts of noise will be most intense in the residential / urban areas.	1. The routing, timing and logistics of the haul truck movement should be planned to have minimal impacts on noise level. 2. The route selection will avoid any sensitive receptors. 3. Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. 4. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. If baseline noise is below the CPCB and IFC-EHS standards, the construction noise has to meet these standards that is, construction noise level has to be less than level prescribed in these standards. 5. Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. 6. Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities. 7. Monitoring required during construction, including field observations and measurements.	Contractor	GC/ CMRL
		Social	Incessant movement of trucks could create social issues. This will have higher occurrences near depots.	1. The local community has to be taken into confidence before the construction commences. Their advice must be taken and incorporated in decision making. 2. Grievance Redress Mechanism for affected people should function effectively with grievance log well documented.	Contractor	GC/ CMRL
		Health & Safety	The movement of trucks will increase the traffic risk of the commuters.	1. The routing, timing and logistics of the haul truck movement should be planned to have minimal impact on occupational and community health and safety.	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
25.	Dumping of excavated materials	Air	The dumping operation of excavated material will generate fugitive dust in the nearby areas	1. Site of dumping shall be selected by contractor in consultation with CMRL and authorities. 2. The disposal plan will be stringently implemented with site monitoring and inspections. 3. It will be located outside of urban habitation. 4. Sprinkling of water should be carried out. Water shall be sourced from surface runoff, wastewater from construction sites, construction yards and seawater. Use of municipal treated water shall be minimized. Groundwater extraction shall be avoided.	Contractor / GC	CMRL /CMDA/ GCMC / TNSPCB
		Soil	Dumping may increase the height of the land and affect the natural drainage pattern of the area	1. The dumping will be done in pre-designated low lying areas identified by CMDA, TNPCB, and CMRL for this specific purpose. 2. The disposal plan will be stringently implemented with regular monitoring and inspections. 3. Field inspections, monitoring, and documentation of dumping excavated materials.	Contractor	GC/ CMRL
26.	Traffic diversion	Air	The under construction areas will be restricted for human and vehicular movements. This will result in detouring of vehicles and/or pedestrians, on the project line which passes through busy urban areas. This may also result into traffic congestion and air pollution from stagnated vehicles in urban areas. Primary pollutants will be NOx, CO, NMHC, and VOCs.	1. Permission from Chennai Traffic Police will be sought before commencement of work. Detours will be properly planned and enacted during non-peak hours only, if possible. Traffic marshals will be posted near such detours. Proper signage has to be posted informing motorists about detours following IRC norms. 2. Adaptive management with field inspections and monitoring during plan implementation and adjustments, as needed, to reflect actual traffic congestion or related issues 3. The Contractor will discuss and coordinate the implementation of the traffic re-routing scheme particularly at station area when it starts the cut and cover activities and the hauling and disposal of excavated materials to the project sites.	Contractor	GC/ CMRL/ Traffic Police

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Noise	Barricading & detouring may result into traffic congestion in the urban areas. This will result into (a) noise from vehicular movement and (b) honking noise due to congestion.	1. Permission from Traffic police will be sought before commencement of work. Detours will be properly planned and enacted during non-peak hours only, if possible. Traffic marshals could be posted near busy intersections, to oversee the smooth flow of traffic. 2. Detour route selection to avoid sensitive receptors to noise. 3. Adaptive management with field inspections and monitoring during plan implementation and adjustments, as needed, to reflect actual traffic congestion or related issues.	Contractor	GC/ CMRL
		Social	Traffic diversion (especially. for public transport) will create inconvenience	1. Implement the traffic management plan. Plans will be made to spare traffic diversion during peak hours (morning and evening peaks). Also separate arrangements for bus, auto and taxi parking bays will be made. Street furniture for pedestrians will be provided wherever possible. 2. Real-time communication to public prior to site-specific work (for example, via signs, radio, and newspaper) and during key periods of traffic interference or peak traffic. 3. Adaptive management with field inspections and monitoring during plan implementation and adjustments, as needed, to reflect actual traffic congestion or related issues.	Contractor	GC/ CMRL
		Resource consumption	Detouring will increase the road length to be travelled by a car, thus, increasing the overall fuel consumption.	1. The detour will be planned to be optimum in terms of road length. The faster completion of works will also tend to reduce enhanced fuel consumption.	Contractor	GC/ CMRL
27.	Restricted pedestrian movement	Social	Restricted pedestrian movement will cause social uproar, esp. in people living near metro stations	1. Safe passage for pedestrians with proper sunshade / fall protection and signage will be planned. Public consensus will be built. Representatives of non-governmental organisation and volunteers from local communities at	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				respective sections of the project shall be invited to participate in meetings with CMRL, GC, and Traffic Police where joint decision on diversion measures will be arrived at. 2. Grievance Redress Mechanism for affected people should function effectively with grievance log well documented.		
		Health & Safety	Movement though constricted space may cause potential health & safety issues amongst pedestrians	1. Safe passage for pedestrians with proper fall protection and signage will be planned.	Contractor	GC/ CMRL
28.	Muck generation & disposal (incl. spent Bentonite & drill fluid and slurry)	Surface water	Muck generated incl. spent Bentonite & slurry from drilling operations will drain with surface runoff and pollute nearby water bodies	1. Muck disposal plan will be stringently implemented with regular monitoring and inspections. 2. The construction sites will be provided with garland drains with intercepting pits to trap silt & muck. 3. Muck will be stored in lined tanks / ponds (if such area is available). Or mechanically dewatered if such area is unavailable. After screening & detention, supernatant liquid from such tanks should be discharged into drainage lines adhering to CPCB standards. Such tank/ ponds could be covered during monsoon to control runoff. 4. The temporary muck storage areas will be maintained by the Contractor at all times until the excavate is re-utilized for backfilling or disposed of as directed by Employer. Dust control activities will continue even during any work stoppage 5. Transportation of muck will be scheduled by time and route to minimize air pollution in habitat areas.	Contractor	GC/ CMRL
		Groundwater	Muck, spent bentonite & drill fluids may settle down from pond / tanks and will affect groundwater	1. The tanks/ ponds holding muck will be lined to prevent infiltration into groundwater. It will be passed through precipitation chambers and discharged into public sewers; it will be treated by municipal agencies to EPR	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				1986 standards of discharge of general effluents into surface water.. 2. Groundwater quality monitoring.		
		Aesthetics	Muck generation will create an aesthetic issue	1. The construction site will be covered from all sides to reduce visual impacts.	Contractor	GC/ CMRL
29.	Steel structure preparation	Soil	Steel structure preparation will create steel scraps	1. Steel scrap will be collected, sorted by diameter and sold to scrap dealers on alter date.	Contractor	GC/ CMRL
		Health & safety	Bar bending & other activities (inc. working at heights) might pose a H&S threat to workers	1. Workers will be provided appropriate hand gloves and personal protective equipment (PPE). 2. Skilled workers working at height or doing hot work will be required to seek permission from site	Contractor	GC/ CMRL
30.	Stacking & warehousing of raw material	Surface water	Washed out raw material could pose serious threat to surface water bodies	1. Small dikes and garlanding drains along the periphery of the yard and ploy boundary could be constructed. This will control runoff and washing out of finer material.	Contractor	GC/ CMRL
		Soil	Spillage of materials / mix products on the ground could pollute soil	1. Proper care will be taken. Such spills will be cleared by scraping and disposing the products as road sub-grade material.	Contractor	GC/ CMRL
		Health & Safety	Fine products like cement/ silt/ sand could cause harm to respiratory system.	1. Cement and sand will be stacked under tarpaulin and secured by GI sheet barricading (working & wind break). Shorter work shift and daily medical checkups of workers will be implemented. 2. Dust filters atop cement silos, wet suppression for aggregate crushing and screening will be employed.	Contractor	GC/ CMRL
		Aesthetics	Stacking of raw material will cause aesthetic issues for residential areas located nearby	1. The height of walls between the residential area and RM yard / construction area will be raised using GI sheets.	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
31.	RCC pouring (using concrete pump)	Noise	RCC pouring using concrete pump will generate low frequency rumbling noise. This will be more perceived and irritating in residential areas.	1. RCC pumps will be covered from all sides. 2. Bends and excessive head will be avoided. 3. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. If baseline noise is below the CPCB and IFC-EHS standards, the construction noise has to meet these standards that is, construction noise level has to be less than level prescribed in these standards.	Contractor	GC/ CMRL
		Soil	Spillage from concrete pouring may contaminate soil	1. The spoils from pouring concrete will be collected and reused as sub-grade material in road construction.	Contractor	GC/ CMRL
		Aesthetics	Spoils from concrete pouring will create unpleasant looking visuals	1. After each pouring cycle, the spoils will be manually collected and reused as sub-grade material in road construction.	Contractor	GC/ CMRL
32.	Setting of concrete (using needle vibrator)	Noise	Needle vibrators generate low frequency noise when dipped in concrete and high frequency noise when raised. Sound level vary between 82-93 dB (A).	1. If the consistency of concrete could be altered, the need for use of vibrator (esp. in low temperature & low thickness casting) could be reduced. Damping could be used to reduce high frequency noise, and thereby reducing the noise levels. Workers should be provided with suitable PPEs. 2. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed per IFC/WB guideline. If baseline noise is below the CPCB and IFC-EHS standards, the construction noise has to meet these standards that is, construction noise level has to be less than level prescribed in these standards.	Contractor	GC/ CMRL
		Soil	During setting, spillage from cast could take place.	1. The spoils from pouring concrete will be collected and reused as sub-grade material in road construction.	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
33.	Curing of concrete (use of water)	Surface water	Curing water will drain to the low lying areas and pollute water courses	1. Garland drainage is proposed to be constructed around the construction yard. This will intercept the runoff generated from site. Rainwater harvesting (as a compensatory measure) will be practiced. Curing needs will be met from municipal supply, water resulting from dewatering during piling and surface runoff water. 2. After precipitation it shall be discharged into public sewers; it will be treated by municipal agencies to EPR 1986 standards of discharge of general effluents into surface water.	Contractor	GC/ CMRL
		Groundwater	Curing water will drain to the low lying areas and pollute water courses	1. In view of low groundwater levels risk of saline water ingress due to proximity of sea coast, use of groundwater will not be resorted to.	Contractor	GC/ CMRL
		Aesthetics	Curing will create water impounding and may lead to vector propagation	1. Garlanding drain will be constructed around the construction area. The curing water impounded will be reused for curing.	Contractor	GC/ CMRL
34.	Use of Crane & Launchers	Noise	Operation of launchers and crane will generate noise which in times may go up to 85-90 dB (A). Legris & Poulin has found that the average daily noise exposure was approx. 84 to 99 dB (A) for heavy equipment, and 74 to 97 dB (A) for the crane operators.	1. The sensitive receptors (workers & external parties, if applicable) have to be isolated from heavy construction noise generated. This is possible by erecting reinforced 2 m tall GI sheet barrier around the area where heavy construction works is undertaken. 2. Workers working inside or near construction equipment should be provided with proper PPEs like ear plugs / muffs complying with IS 4869. 3. If baseline noise is below the CPCB and IFC-EHS standards, the construction noise has to meet these standards that is, construction noise level has to be less than level prescribed in these standards. 4. Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				commencement and kept updated as to changes in the management and mitigation plan. 5. Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities.		
		Health & Safety	Cranes and launchers are a major safety concern.	1. As per SHE, operation of launchers and cranes should be only done under the strict supervision of a qualified engineer and a safety supervisor. Only qualified & trained crane/ launcher operators should be allowed. Proper examination of crane, launchers, labours& operators should take place before commencement of work.	Contractor	GC/ CMRL
35.	Construction of labour camp(s) and associated environmental issues	Surface water	Sewage from labour camps may be discharged into open slopes thus contaminating surface water	1. Labour camps will be constructed in semi urban / urban set-ups. It shall be discharged into public sewers; it will be treated by municipal agencies to EPR 1986 standards of discharge of general effluents into surface water..	Contractor	GC/ CMRL
		Groundwater	Surface water on flat terrain could percolate and contaminate groundwater.	1. Contractor to collect the groundwater baseline date prior to construction. 2. Disposal in compliance with applicable regulatory requirements. 3. Groundwater quality monitoring.as per EMoP 4. Water abstracted must be measured/ recorded periodically. 5. After Construction, Contractor will conduct groundwater analysis and be obliged to reinstate the used sites no worse than the conditions of pre-construction.	Contractor	GC/ CMRL
		Soil	Solid waste generated from the labour camps will cause soil pollution	1. Contractor to collect the soil baseline date prior to construction. 2. Municipal solid waste will be collected and taken away and disposed by municipality.	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				3. Solid waste will have to be disposed in compliance with Municipal Solid Waste (Management & Handling) Rules, 2000, as amended to date. 4. After Construction, Contractor will conduct soil analysis and be obliged to reinstate the used sites no worse than the conditions of pre-construction.		
		Social	Influx of non-local labours will create a social issue	1. Mixing of skilled non-local labours with local unskilled people will reduce social frictions. 2. To avoid labor influx risk, sensitizing of local community and the non-local workers separately as well as jointly will be done regularly.	Contractor	GC/ CMRL
		Health & safety	Living in congested condition, make-shift temporary arrangement; the labours are prone to diseases.	1. Regular counselling, medical checkups and treatment at separate clinics, coordination with local health authorities will be conducted. 2. Per Building & Other Construction Workers (BOCW Regulation of Employment and Conditions of Service) Act, 1996 the employer (contractor) is liable to arrange for sanitation, health care facilities of labours, free of charge. Labour camps will be in full compliance of BOCW Act. 3. COVID-19 protocols for construction forming part of the Environmental Social Health and Safety Requirements shall be fine-tuned to be adopted for labour camps; camp residents shall be trained and informed of precautions such as social distancing, sanitizing, avoiding groups; arrangements for thermal scanners; provision of sanitisers, face masks, gloves; record of COVID-19 hospitals; protected ambulances at camp; daily disinfection of site, equipment and camp.	Contractor	GC/ CMRL
		Resources	Labours will consume resources like wood for cooking	1. Liquid petroleum Gas cylinders will be made available free of cost to the labourers by the Contractor. 2. Labour camps are provided with canteen systems. They shall be provided with treated water for drinking, bathing and other needs.	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
36.	Loading /unloading of construction material	Air	Loading & unloading of construction material will generate fugitive dust	1. The traffic management plan will be stringently implemented with regular monitoring and inspections. 2. The trucks/dumpers carrying the material will be covered using tarpaulin/similar covering materials. 3. Fugitive dust could be controlled using water sprinkling. Contractors should carry out water sprinkling. 4. Truck tires will be washed to excess remove soil clinging to it. Contractor will provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt. Used water shall be collected, subject to precipitation and re-used. 5. Water for sprinkling and tire washing will be sourced from surface runoff, wastewater from construction sites, construction yards and seawater.	Contractor	GC/ CMRL
		Noise	Loading & unloading of construction material will generate noise	1. The RM storage yard will be separately built and enclosed from all sides. This will reduce noise generation at site. 2. Concrete preparation will only take place in casting yards (away from habitation). 3. If baseline noise is below the CPCB and IFC-EHS standards, the construction noise has to meet these standards that is, construction noise level has to be less than level prescribed in these standards. 4. Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. 5. Enclose especially noisy activities if above the noise limits and employ transportable noise screens between	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				noise sources and identified noise sensitive areas for the duration of noisy construction activities.		
		Health & safety	Fugitive dust and noise generation will have potential health & Safety implications.	1. Cement and sand will be stacked under tarpaulin and secured by GI sheet barricading (working & wind break). Shorter work shifts and regular health checkups will be implemented. The RM storage yard will be separately built and enclosed from all sides. The worker will be provided with suitable PPEs. Also they will be trained and encouraged in using PPEs.	Contractor	GC/ CMRL
37.	Use of batching plant	Air	Loading & unloading of construction material into batching plant will generate fugitive dust	1. High GI sheet screens and water sprinkling will be employed. 2. Batching plant / casting yard shall be barricaded and made as a compulsory PPE zone. This will effectively reduce the fugitive dust generation.	Contractor	GC/ CMRL
		Noise	Operation of batching plant will generate noise	1. GI sheet barricading around batching area and worker PPE like ear muffs will be used. 2. Batching plant / casting yard shall be barricaded and made as a compulsory PPE zone. This will reduce the impacts of noise generation. 3. If baseline noise is below the CPCB and IFC-EHS standards, the construction noise has to meet these standards that is, construction noise level has to be less than level prescribed in these standards.	Contractor	GC/ CMRL
		Soil and Groundwater	Runoff of waste can contaminate soil and groundwater	1. Contractor to collect baseline soil and groundwater quality data prior to operate the plants. 2. Municipal water will be used. In view of fragile groundwater status, extraction will be avoided. 3. The construction sites will be provided with drains with intercepting pits in which the cement and sand will settle. After screening & detention, liquid will be discharged into drainage lines. Disposal in compliance with applicable regulatory requirements. After precipitation, it shall be	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				discharged into public sewers; it will be treated by municipal agencies to EPR 1986 standards of discharge of general effluents into surface water. 4. Soil and Groundwater quality monitoring. 5. After Construction, Contractor will conduct soil and groundwater analysis and be obliged to reinstate the used sites no worse than the conditions of pre-construction.		
		Hazardous waste	Health impacts and soil and groundwater pollution from hazardous water at batching/casting yards	1. The use and storage of hazardous materials at the casting yard and batching plant should adhere to SPCB requirements. 2. The transport, handling and storage of hazardous waste will be done in accordance with the provisions of Hazardous Chemicals (Management & Handling) Rules. Hazardous wastes from construction activity and equipment are labeled, recorded, stored in impermeable containment and for periods not exceeding mandated periods and in a manner suitable for handling storage and transport. 3. The contractor shall maintain a record of sale, transfer, storage of hazardous waste and make these records available for inspection. 4. The contractor shall get Authorized Recyclers to transport and dispose Hazardous Waste. 5. Proper collection and storage facilities will be provided especially for hazardous waste.	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Resources	If the batching plant will get its power from DG sets, substantial diesel will be consumed. (A 30 m3/hr. batching plant will require approx. 60 KW/hr. (or, approx. 75 KVA, assuming PF = 0.8) energy. In most cases the Contractor has used DG sets (from 100 – 250 kVA) for batching plant & ancillary facilities. Thus, the diesel req. will range from 30 - 45L/hr, at 100% load)	1. If power from the grid is used, permission from power supply company must be obtained by the Contractor. 2. DG sets, if used, should: (a) conform to height of stack norms as per CPCB rules; (b) conform to emission norms as per E (P) Act, 1986; (c) noise level at 1 m distance from enclosure should not be >75 dB(A). 3. The required permissions from local Environmental Authorities/Pollution Control Board/ CEIG or any other relevant Authority shall be obtained by the Contractor for using DG sets for power supply. 4. Diesel storage if done beyond threshold limit (1000 L) permission should be obtained. Diesel should be stored on pukka platforms and spillages should be avoided. 5. Refer to Activity 42 “Use of DG sets” and Activity 44 “Storage of Diesel” for further measures.	Contractor	GC/ CMRL
38.	Casting of segments and I-beams	Groundwater	Casting will require use of water	1. Chennai Metropolitan Water Supply and Sewerage Board/ Municipal water will be used. In view of fragile groundwater status, extraction will be avoided. 2. The construction sites will be provided with drains with intercepting pits in which the cement and sand will settle. After screening & detention, liquid will be discharged into drainage lines. Disposal in compliance with applicable regulatory requirements. After precipitation, it shall be discharged into public sewers; it will be treated by municipal agencies to EPR 1986 standards of discharge of general effluents into surface water. 3. Groundwater quality monitoring.	Contractor	GC/ CMRL
		Resources	Casting (incl. operation of gantry and hydraulic pre-stressing units) will consume lot of energy	1. Pre-stressing and casting are basic requirements. However, most of the power should be drawn from approved lines, not from DG sets.	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
39.	Curing of segments & I-beams	Groundwater	Curing will require a significant amount of water	1. Garland drainage is proposed to be constructed around the construction yard. This will intercept the runoff generated from site. Stagnation of water (and resultant vector propagation) should be avoided. 2. Groundwater quality monitoring. 3. After precipitation, it shall be discharged into public sewers; it will be treated by municipal agencies to EPR 1986 standards of discharge of general effluents into surface water. 4. Groundwater will not be used. Water will be sourced from municipal supply, surface runoff or dewater.	Contractor	GC/ CMRL
40.	Hauling of segments to site	Air	During transportation of segments, fugitive dust will be generated from re-suspension of dust from road surface. Plus, there will be air emission from trucks	1. The traffic management plan will be stringently implemented with regular monitoring and inspections. 2. The trucks/dumpers carrying the excavated material will be covered using tarpaulin/similar covering materials. 3. Sprinkling of water should be carried out. 4. Truck tires will be washed to excess remove soil clinging to it. Contractor will provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from construction depots and batching plants. At such facility, high-pressure water jets will be directed at the wheels of vehicles to remove all spoil and dirt. Used water shall be collected, subject to precipitation and re-used. 5. Water for sprinkling and tire washing will be sourced from surface runoff, wastewater from construction sites, construction yards and seawater. 6. Haul roads will be kept in good state of maintenance.	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Noise	Trucks carrying segments will result into high noise (typically in excess of 85 dB(A) at1 m distance, or 57 dB(A) at 10 m distance). The adverse impacts of noise will be most intense in the residential/urban areas	1. The routing, timing and logistics of the haul truck movement should be planned to have minimal impacts on noise level. The route selection will avoid any sensitive receptors. 2. Efforts should be made to keep the noise levels under control by appropriate noise attenuation and adopting employee safety measures. 3. If baseline noise is below the CPCB and IFC-EHS standards, the construction noise has to meet these standards that is, construction noise level has to be less than level prescribed in these standards. 4. Information dissemination to local residents and shop owners about the nature and duration of intended activities including the construction method, probable effects, quality control measures and precautions prior to commencement and kept updated as to changes in the management and mitigation plan. 5. Enclose especially noisy activities if above the noise limits and employ transportable noise screens between noise sources and identified noise sensitive areas for the duration of noisy construction activities. 6. Monitoring required during construction, including field observations and measurements.	Contractor	GC/ CMRL
		Social	Incessant movement of trucks could create social issues	1. The local community has to be taken into confidence. Their advice has to be taken and incorporated in decision making.	Contractor	GC/ CMRL
		Health & safety	The movement of trucks will increase the traffic risk of the commuters	1. The routing, timing and logistics of the haul truck movement will be planned to have minimal impacts on occupational and community health and safety.	Contractor	GC/ CMRL
		Aesthetics	Movement of trucks will create an aesthetic problem	1. Proper housekeeping activities have to be undertaken near the casting yard and nearby areas.	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
41.	Use of DG sets	Air	Emission of NO_x, SO_x, CO, PM_{10}, $PM_{2.5}$ from DG sets will create air pollution problems	1. Primary power source will be power distribution company, DG sets will be used only for power back-ups for stations. 2. The required permissions from local Environmental Authorities/Pollution Control Board/ CEIG or any other relevant Authority shall be obtained by the Contractor if using DG sets for power supply. DG sets compliant with CPCB norms will be used. Specification no. GSR 520(E) dt. 1-7-2003 for DG sets rating < 800 KW, and GSR 489(E) dt. 09-07-2002 for DG sets > 800 KW under E (P) Rules, 1986. 3. Stack height of DG sets will be as per CPCB requirement [stack ht. = 0.2*(rating in kVA)0.5] 4. Stack monitoring will be conducted monthly of the criteria pollutants. 5. Compliance monitoring will be done to the regularly and check the monitoring instruments. 6. Fuels used for DG will be High Speed Diesel with low-sulfur content.	Contractor	GC/ CMRL
		Noise & Vibration	Noise & vibration will be generated from the use of DG sets	1. DG sets compliant with CPCB norms will be used. 2. If baseline noise is below the CPCB and IFC-EHS standards, the construction noise has to meet these standards that is, construction noise level has to be less than level prescribed in these standards 3. Monitoring required during construction, including field observations and measurements. 4. DG sets will be enclosed type, with noise levels approx. 75 dB (A) at a distance of 1m in compliance with GSR 371(E) dt. 17-05-2002. 5. Noise will be controlled using acoustic enclosure. 6. The DG sets will be mounted on damping skids, which will reduce the vibration generated from DG sets.	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
		Resources	DG sets will consume Diesel (and in effect reduce the levels of a non-renewable resource)	1. DG sets should always be use as a power back up, and not the primary sources of power. This should be made mandatory for all Contractors. 2. Refer to Activity 44 “Storage of Diesel” for further measures.	Contractor	GC/ CMRL
		Aesthetics	Operation of DG sets will cause an aesthetic issue	1. Enclosures will be used to keep them off from public views. 2. PM content of DG sets smoke will be as pert the CPCB norms, thus the DG will emit dark smokes only during start-up & shut-down (b) Noise will be controlled using acoustic enclosure.	Contractor	GC/ CMRL
42.	All Construction Activities	Environment	Construction and Demolition (C&D) waste results from land clearing, excavation, construction, demolition, remodeling and repair of structures, roads and utilities	1. Records of movement and loading/unloading of C&D waste and records of waste loaded by vendors. 2. C&D waste will be reused/recycled as it has the potential to save natural resources (stone, river sand, soil etc.) and energy. C&D waste generated from metro construction has potential use after processing and grading. 3. The contractor will segregate and temporarily store the C&D waste till the vendor takes it away for recycling and disposal at authorized facilities. 4. Contractor will adhere with the C&D Waste Management Rules.	Contractor	GC/ CMRL
		Occupational Health and Safety	Accidents All parties’ reputation	1. Worker safety is important on all construction projects. It is important to consider the effects of staffing on worker safety and to provide appropriate training in safety awareness for all labor. 2. The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reach 140 dB(C), or the average maximum sound level reaches 110dB(A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85 dB(A).	Contractor	GC/ CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
43.	Storage of Diesel	Groundwater	Diesel spillage (from underground or above ground storage facility) will affect groundwater quality adversely	1. Before it percolates into the groundwater, contaminated runoff water can be run through adsorbents such as bentonite to remove the diesel. The diesel will be quickly collected into steel trays and disposed to authorized recyclers. 2. All bulk diesel tanks shall be properly supported in an elevated position to facilitate gravity discharge. They shall stand within a bund constructed to contain a volume of110% of the volume of the tank. There shall be no breaches in the bund wall, no material shall be stored within the bund and rain water collecting in the bund shall be regularly removed to prevent build-up. 3. Spillage will be controlled using methods mentioned in the environmental contingency plan. 4. Groundwater quality monitoring.	Contractor	GC/ CMRL
		Health & safety	Storage of Diesel will attract the provisions of Hazardous Chemicals (Management & Handling) Rules and Petroleum Rules; as amended to date. It could cause serious damage to health & safety of workers / property if ignited	1. Proper onsite emergency plan will be prepared and will be approved through CMRL. 2. If the diesel storage crosses the threshold limits permissions, proper fire protection norms have to be undertaken as per National Building Code, 2005 (if building)/ Oil Industry Safety Directorate Standard 117 (if installation).	Contractor	GC/ CMRL
44.	Cleanup Operations, Restoration and Rehabilitation	Environment	Aesthetics	1. The clean-up and restoration operations are to be implemented by the Contractor prior to demobilization. All spaces excavated and not occupied by the foundation or other permanent works shall be refilled with earth up to surface of surrounding ground.	Contractor	GC/ CMRL
Operational Phase						

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
45.	Operation of metro trains	Noise and Vibration	The most significant source of noise will be rolling noise from contact between wheel and rail including noise from contact between the brake pad and wheel, followed by engine noise and aerodynamic noise.	1. To minimize operation stage impacts measures such as Ballast less track structure is supported on two layers of rubber pads to reduce noise and vibrations. In addition, baffle wall as parapets will be constructed up to the rail level so as reduce sound levels. Noise at source will be controlled or reduced by incorporating suitable feature in the design of structures and layout of machines and by use of resilient mounting and dampers etc. 2. Since the rakes will be air conditioned and enclosed from all side, the impacts of noise on the travelers will be nominal. 3. Noise barriers will be installed at locations based on final design noise prediction analysis. 4. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. If baseline noise is below the CPCB and IFC-EHS standards, the operation noise has to meet these standards that is, noise level has to be less than level prescribed in these standards. 5. The mitigations suggested based on the detailed noise and vibration analysis, should be strictly followed.	CMRL	CMRL
		Aesthetics	Metro rail will increase the aesthetics of Chennai	1. A proper housekeeping routine will be followed to enhance the aesthetics of metro rail station.	CMRL	CMRL
		Health and Safety	Accidents Reputational risks	1. Detailed specification of equipment e.g. power cables, rectifiers, transformer, E&M equipment etc. shall be framed to reduce conducted or radiated emissions as per appropriate international standards. 2. The Metro system as a complete vehicle (trains, signaling & telecommunication, traction power supply, E&M system etc.) shall comply with the Electromagnetic compatibility (EMC) requirements of international standards viz. EN50121-3-1, EN50123, IEC61000 series etc. EMC requirements of international standards for whole railway system to the outside world shall comply with EN50121-2.	CMRL	CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				3. A standby silent type DG set of adequate capacity will sustain the following: essential lighting, signaling, and telecommunications, fire-fighting system and lift operation. 4. Automatic Train Protection and Automatic Train Supervision sub-systems will be installed to provide a high level of safety. 5. CCTV system will be installed for local and centralized monitor of operation. 6. In view of the potential hazards from system failure resulting to accidents, both on- site and off-site emergency measures will be implemented. All trains will have public address systems to warn the passengers of any emergency. 7. Emergency team, ambulance, contact number and hospital should be available. Emergency response plan should be implemented during operation periods.		
			Operating Personnel Health risks	1. Operating staff such as drivers and Control Centre staff shall be administered regular medical checkups for musculo-skeletal disorders, fatigue, eye strain. 2. Well designed workstations, lighting in Control Centre. 3. Emotional resilience training, counselling for recovery and rehabilitation	CMRL	CMRL
			Severely contagious diseases such as COVID-19 can impact health of staff thereby affecting operations; can cause economic loss to the country and loss of reputation to the project.	1. Chennai Metro COVID-19 SOP shall be implemented; staff shall be trained; staff and commuters shall be informed of precautions such as social distancing, sanitizing; arrangements for stationary and hand-held thermal scanners; provision of sanitizer pedestals, vending machines of face masks and gloves etc. shall be provided in stations; site record of COVID-19 hospitals; daily disinfection of operating rooms, circulation spaces, equipment and vehicles; protected ambulances at stations.	CMRL	CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
46.	Track repair	Environment	Spill accidents	1. CMRL to ensure no illegal disposal of solid waste or wastewater.	CMRL	CMRL
47.	Use of DG sets	Air	Emission from DG sets will create air pollution problems	1. DG sets compliant with CPCB norms will be used.	CMRL	CMRL
		Noise	Noise & vibration will be generated from the use of DG sets	1. DG sets compliant with CPCB norms will be used. Monitoring of air quality shall be done as per CPCB norms. 2. Noise enclosures will be used. 3. Wherever baseline noise already exceeds the standards, only 3dB of noise increase is allowed. If baseline noise is below the CPCB and IFC-EHS standards, the operation noise has to meet these standards that is, noise level has to be less than level prescribed in these standards.	CMRL	CMRL
		Groundwater	Diesel spillage (from underground or above ground storage facility) will affect groundwater quality adversely	1. Diesel should be stored in designated sites prior to final relocation. 2. Oil that is mixed in water will be removed in the ETP.	CMRL	CMRL
		Health & safety	Storage of Diesel will attract the provisions of Hazardous Chemicals (Management & Handling) Rules and Petroleum Rules; as amended to date. It could cause serious damage to health & safety of workers / property if ignited	3. Diesel should be stored in designated sites prior to final disposal. 4. Fire fighter is equipped at storage site. 5. Proper onsite emergency plan will be prepared by GC and will be approved through CMRL.	CMRL	CMRL
		Aesthetics	Operation of DG sets will cause an aesthetic issue	1. Enclosures will be used.	GC / CMRL	CMRL
		Resources	DG sets will consume Diesel (and in effect reduce the levels of a non-renewable resource)	1. DG sets compliant with CPCB norms will be used only as backup.	CMRL	CMRL

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
48.	Development of feeder routes	Social	Along with Metro routes, metro feeder routes will be developed. This will have a positive impact in terms of enhanced connectivity and inclusion in the social mainstream	1. CMRL will work with bus operators to implement metro feeder routes along major arterial and sub-arterial routes to reduce travel time to the nearest station. Better quality coaches & comfortable rides should be planned to enhance acceptability.	GoTN	GoTN
		Aesthetics	Better designed coaches will enhance ride pleasure and aesthetics	1. The buses coaches should be properly maintained from time to time in order to enhance the aesthetic value.	GoTN	GoTN
		Health & safety	Better & frequent transport system will reduce risk of traffic accidents	1. The new feeder routes should (a) follow proper timetable; (b) should have frequent services during the morning & evening peak;(c) should have a limited carrying capacity. The feeder buses should arrive and depart from designated bus bays or similar structures. Proper arrangements for road crossing should be established. The appointed personnel should assist passengers to reach their destinations. An easily accessible grievance redressal system should be established by CMRL.	GoTN	GoTN
49.	Generation of employment	Social	The proposed project will result into generation of employment	1. The project will cause direct and indirect employment generation. Economic activity will be stimulated by easier movement of passengers thus leading to indirect employment generation.	GoTN	GoTN
50.	Ancillary development along metro route	Social	Ancillary development along the metro alignment will have positive effect on the social environment	1. There should be positive participation of the common people in the ancillary development process. An open, transparent & people-centric outlook has to be adopted.	GC / CMRL	GoTN
		Land	Ancillary developments will take place along with metro corridor	1. Provision for increased density of development along project corridor is available through existing byelaws as well as new ToD norms. Mixed land use of ToD tends to reduce non-work trip length and its higher density promotes increased use of metro for work trips on long distances.	GoTN	GoTN

SN	Activity	Aspect /Parameter affected	Impact	Mitigation measures	Responsibility	
					Implementation	Supervision
				2. Implementation of increased densities is decided by State Government and managed by CMDA in accordance with demand.		

GCMC Greater Chennai Municipal Corporation CMDA Chennai Metropolitan Development Authority TNSPCB Tamil Nadu State Pollution Control Board
GC General Consultant

Table 9.3: Environmental Monitoring Plan

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated cost (USD)
Pre-Construction stage					
Air	Emission of dust and particulate matter as PM2.5 and PM10, NOx and SOx, CO	GoI and WHO/IFC whichever stringent	Once, 24 hours continuously	Each station, batching plant and casting yard, Muck disposal site	4,658
Water (Surface and Ground)	DO, Turbidity, Conductivity, pH, Heavy metals, E.Coli, TSS, Oil and Grease, VOCs and Volatile Chlorinated Hydrocarbons (groundwater only) and TDS	GoI and WHO/IFC whichever stringent	Once, 3 samples each location	Groundwater at batching plant and casting yard, Muck disposal site, construction camps and 29 excavation sites Surface water at wherever waterbody located within 100m from sites	11,712
Soil	pH, Sulphate (SO3), Chloride, ORP, water Soluble salts EC, Organic Matter (Oil), Heavy metals, Poly-Aromatic Hydrocarbons (PAH), Moisture Content	GoI and WHO/IFC whichever stringent	Once, 3 samples each location	At batching plant and casting yard, Muck disposal site, construction camps and 29 excavation sites	11,096
a) Noise & vibration b) Building condition survey	Noise levels in dB(A) Vibration PPV mm/s Building condition survey	GoI and WHO/IFC whichever stringent Federal Transit Administration (FTA) Guideline Standards or any other internally recognized standards	a) Once Hourly basis for 24 hours (noise & vibration) b) Building Condition Survey: height measurements, crack survey, detailed photographic records etc.	a) At key structure locations b) At pre-identified culturally valuable sites if any near the alignment, or finds in the project's direct area of impact.	a) 11,397 b) To be decided during pre-bid joint site visit of CMRL & Contractor and cost included in bid
Biodiversity (Species, Population, Nests and Breeding sites) survey	Number of nests, breeding sites population size for target species confirmed by Forest Department, Fisheries Department, GoTN If any of above found during site clearance, they will be transferred	GoI and IFC EHS Guideline and Guidance Note 6 or any internationally recognized guidelines whichever stringent	Once, prior to site clearance	Nanmangalam reserve forest, Pallikaranai marsh / other affected Marshlands, Adyar River, Adambakkam Lake and any other ecologically sensitive locations	4,110

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated cost (USD)
	to a safe place as guided by the biodiversity expert and TNFD/Wildlife/Fisheries.				
Sub-total					42,973
Construction stage					
Air	Emission of dust and particulate matter as PM2.5 and PM10, NOx and SOx, CO	GoI and WHO/IFC whichever stringent	24 hours continuously every month	For each station until civil works completed batching plant and casting yard, Muck disposal site throughout construction phase	112,877
Water (Surface and Ground)	DO, Turbidity, Conductivity, pH, Heavy metals, TN, TP, E.Coli, TSS, Oil and Grease, VOCs (groundwater only) and TDS	GoI and WHO/IFC whichever stringent	Quarterly, 3 samples each location	Groundwater at batching plant and casting yard, Muck disposal site, construction camps throughout construction phase, and excavation sites stations until civil works completed Surface water at wherever waterbody located within 100m from sites	100.274
Soil	PH, Sulphate (SO_3), Chloride, ORP, water Soluble salts EC, Organic Matter (Oil), Heavy metals, PAH, Moisture Content	GoI and WHO/IFC whichever stringent	a) Quarterly, 3 samples each location	a) At batching plant and casting yard, Muck disposal site, construction camps throughout construction phase b) 28 excavation sites-once during construction, once post-construction	26,507
a) Noise, b) Vibration c) Building Condition Survey	a) Noise levels in dB(A) b) Vibration PPV mm/s c) Building Condition Survey	GoI and WHO/IFC whichever stringent Federal Transit Administration (FTA) Guideline Standards or any other internally recognized standards	a) Monthly or when complaint is received Hourly basis for 24 hrs (noise) b) Continuous monitoring during piling (vibration) c) Building Condition Survey: crack sensors, tilt sensors,	a) and b) Key structure locations c) Pre-identified culturally valuable sites if any near the alignment, or finds in the project's direct area of impact.	a) & b) 24,110 c) To be decided during pre-bid joint site

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated cost (USD)
			continuous height measurement etc.		visit of CMRL & Contractor and cost included in bid
Biodiversity	Wildlife Species If any species are found in the construction site, they will be carefully transferred to safe locations within the Forest Land, Marshlands or waterbody under the guidance of the biodiversity expert and the local forestry/wildlife/fisheries agency.	GoI and IFC EHS Guideline and Guidance Note 6 or any internationally recognized guidelines whichever stringent	Weekly during construction at the ecologically sensitive locations	Nanmangalam reserve forest, Pallikaranai marsh / other affected Marshlands, Adyar River and Adambakkam Lake	161,339 (including yearly survey 15,221)
Occupational and Community Health and Safety	As specified in project ESHS plan prepared by Contractor Sub-section F of Section VII and Part D of PCC	IFC General and Sector EHS Guidelines or any other international recognized guidelines, WHO and GoI guidelines on COVID-19	Weekly	Project Site	NA
Sub-total					425,107
Operation Stage					
Air	Emission from DG sets (SPM, NOx and SOx), Odor	GoI and WHO/IFC whichever stringent	At least 2 times in a year for the first year, annually for another 2 years	DG sets of all stations	15,890
Groundwater	DO, Turbidity, Conductivity, pH, Heavy metals, TP, TN, E.Coli, TSS, Oil and Grease, VOCs and TDS	GoI and WHO/IFC whichever stringent	At least 2 times in a year for the first year, annually for another 2 years	Groundwater at Station locations	11,918
Noise	Noise levels in dB(A)	GoI and WHO/IFC whichever stringent	At least 2 times in a year for the first year, annually for another 2 years	Alignment, Stations	3,178
Vibration	PPV mm/s	Federal Transit Administration (FTA) Guideline Standards or any other internally recognized standards	At least 2 times in a years for the first year, annually for another 2 years	At key structure locations	43,836

Environmental Features	Aspect to be Monitored	Standard to be complied with	Time and Frequency of Monitoring	Location	Estimated cost (USD)
Biodiversity	Wildlife Species Carcass	GoI and IFC EHS Guideline and Guidance Note 6 or any internationally recognized guidelines whichever stringent	At least 2 times in a years for the first year, annually for another 2 years	Nanmangalam reserve forest, Pallikaranai marsh / other affected Marshlands, Adyar River and Adambakkam Lake	cost included in bid of GC
Occupational Health and Safety	As specified in project EMP and CMRL's SHE Manual	IFC General and Sector EHS Guidelines or any other international recognized guidelines	Monthly for 3 years	Station	20,548 *
Sub-total					95,370
Grand total					**563,450**

During operation:

Occupational Health and Safety safeguards during operation are not spelt out in the SHE document. Based on experience on other railways, health issues relevant to Chennai metro can be as follows:
a) Musculo-skeletal disorders and fatigue, eye strain due to Display Screens impacting drivers, train controllers and ticketing staff: Well designed workstations, lighting, posture advice and regular health checkups. b) Stress impacting drivers and Train controllers: Risk assessment, changes to job design, task allocation, training, and supervision; emotional resilience training; counselling for recovery and rehabilitation.

* Lumpsum provision Group Insurance premium excluding surgeries and loss of life or limb: Rs five lakh per year

9.5 Emergency Preparedness and Response System

295. An Emergency Preparedness and Response System has been prepared as shown in Table 9.4.

Table 9.4: Emergency Preparedness and Response System

Emergency Situations	Community or individuals impacted	Response procedure	Equipment and resources	Responsibilities	Training need	Accident and emergency records
Damage to utilities: Damage to one of the utilities water supply, sewage, gas pipelines; electric and telecommunication cables while other utilities are being diverted due to lack of clarity in their location or unexpectedly poor state of their maintenance Damage while additional geotechnical investigations are in progress or during pile driving/in-situ casting.	Community In case of live gas lines, the project workforce could also be impacted	• The potential for disruption of utilities during line construction is low as long as proper pre-dig verification procedures are followed. Disruption could range from cable or phone outage to customers, to explosion in gas line with potential risk to human health and life. • Contact utility to clear utility related safety hazard (like deactivating the utility). • Seek assistance of the utility to assess damage • Coordinate with un-impacted utilities. • Vital services and infrastructure recovery activities.	➢For gas utilities • Fire engines to dispense water and foam • Portable extinguishers • Fire protection suits • Breathing apparatus, helmets, goggles and face shield, first aid kits, stretchers, torches, ladders, emergency lighting on standby power ➢For water and sewage utilities • Quick water sealants	Notification: Contractor to CMRL and utility agency CMRL to utility agency Remedial Action by: utility agency	• Mock drills • Use of extinguishers, fire suits, breathing apparatus, first aid kits, water sealants	• Utility location and diversion plans • Record sheet showing type, size and identification number of utility, time of occurrence, time of notifying utility agency, status of other utility lines at the locations, time of repair and resumption of construction activities • Geotagged photographs with date

Collapse or severe degree of damage to existing structures due to unanticipated vibration during construction	Community	• The base document available with the ER Team shows the location of structures which are at risk of damage due to vibration as assessed at start of construction. In case of those structures where damage is expected to be major especially due to age or condition of building, move occupants affected as well as those in their proximity to safer locations *before work is started at those locations.* Arrange for their temporary relocation till the structures are rehabilitated. • In the event of minor damage to non-structural elements of the buildings, the same will be repaired. In case of *unforeseen damage* endangering structural soundness, move occupants of structures affected as well as those in their proximity to safer locations. Arrange for their temporary relocation till the structures are rehabilitated.		Notification: Contractor to CMRL Remedial Action by: Contractor	Mock drills	Vibration records • Record sheet showing type, size and identification number of structure, time of occurrence, type of equipment in use before and when the damage was first noticed, the type of minor repair executed, number of occupants present and evacuated, time of evacuation, status of adjacent structures, type of rehabilitation implemented on each affected structure, date of resumption of construction activities, date of return of occupants • Geotagged photographs with date
Fire accidents at electric installations, fuel storage and fueling facilities	Community and project workforce	• Transformer or Substation fire requires equipment be de-energised. • Use fire water and foam to combat fires of oil.	• Fire engines to dispense water and foam • Portable extinguishers	Notification: Contractor to CMRL and Fire Department, Police, hospitals and Tamil	• Mock drills • First Aid • Use of fire extinguishers, fire suits,	• Fuel and vapour sample test reports • Maintenance reports of electric and fuel installations

		• Immediately cool the equipment and any containers to avoid explosion. • Follow designated stand off distance and stand down period. • Administer first aid	• Fire protection suits • Breathing apparatus, helmets, goggles and face shield, first aid kits, stretchers, torches, ladders, Emergency lighting on standby power	Nadu Pollution Control Board Remedial Action by: Contractor	breathing apparatus • Evacuation • Search and Rescue	• Record sheet showing location and time of occurrence, number of personnel present and evacuated • Geotagged photographs with date
Road accident hazard due to leakage of hazardous waste such as waste fuels, lubricants during transport by vendors	Community and project workforce	• Even if grievous hurt and loss of life to workers and community and property is not caused, if incident occurred in public area posing a hazard, notify Police and alert Pollution Control Board. • Control the leak/flow • Arrange for sampling of any water pollution or potential pollution	• First aid kits, stretchers, torches, ladders, emergency lighting on standby power	Notification: Contractor to CMRL • CMRL to Traffic Police Department and Tamil Nadu Pollution Control Board. Remedial Action by: Contractor	• Mock drills • First Aid • Use of fire extinguishers, fire suits, breathing apparatus	• Waste identification report • Record sheet showing location and time of occurrence, number of personnel present and evacuated • Geotagged photographs with date
Air pollution due to leakage and fire of flammable gases from muck disposal site slope failure of muck stack at disposal site	Community and project workforce	• Even if grievous hurt and loss of life to workers and community and property is not caused, if incident occurred in public area posing a hazard, notify Police and alert Pollution Control Board. • Use fire water	• Fire engines to dispense water and foam • Portable extinguishers • Fire protection suits • Breathing apparatus, gas detectors, helmets, goggles and face shield, first aid kits, stretchers,	Notification: Contractor to CMRL and Fire Department CMRL to Tamil Nadu Pollution Control Board Remedial Action by: Contractor	• Mock drills	• Gas sample test reports • Record sheet showing location and time of occurrence, number of personnel present and evacuated • Geotagged photographs with date

			torches, ladders, Emergency lighting on standby power			
Failed launching of pre-cast girders or segments	Community and project workforce	• Administer first aid • Organise lifting equipment and gas cutters • Even if grievous hurt and loss of life to workers and community and property is not caused, but if collapse occurred in public area posing a hazard, notify Police.	• Lifting equipment and gas cutters • First aid kits, stretchers, torches, ladders, emergency lighting on standby power	Notification: Contractor to CMRL CMRL to Police and district labour Commissioner Remedial Action by: Contractor	• Mock drills • First Aid • Search and Rescue	• Structural drawings of failed elements • Record sheet showing location and time of occurrence, type of lifting equipment used, number of personnel present and evacuated • Geotagged photographs with date
Collapse of temporary works such as scaffolding and excavation support	Community and project workforce	In case of injured worker suspended from his harness, wait for trained emergency personnel.		Notification: Contractor to CMRL CMRL to Police and district labour Commissioner Remedial Action by: Contractor	• Mock drills • First Aid	• Structural drawings of failed temporary works • Record sheet showing location and time of occurrence, number of personnel affected • Geotagged photographs with date
Service disruption and unplanned congestion due to failure of rolling stock doors	Metro Passengers	• As soon as duration of failure approaches disruption period allowed in station design, notify OCC and suspend boarding and alighting at affected station • close entry of passengers into affected stations	Maintenance equipment, spares and personnel	Notification: CMRL to Emergency Action Committee Remedial Action by: CMRL	• Mock drills	• rolling stock usage log • rolling stock maintenance reports • Record sheet showing location and time of occurrence, number of services affected

		• Trains arriving in affected duration will pass without stopping • Affected trains will pass through to maintenance depot for attention				• Geotagged photographs with date
Service disruption and unplanned congestion due to failure of traction power supply or signaling during operation of the metrorail	Metro Passengers	• In case of traction power failure, affected trains reach nearest station on battery. • In case of signalling failure, stop affected trains at nearest station. • Suspend operation of trains bound to pass through affected stations or section; stop trains at stations outside affected section • Close entry of passengers into affected stations	Maintenance equipment, spares and personnel	Notification: CMRL to Emergency Action Committee Remedial Action by: CMRL	• Mock drills	• TPS and S&T log • TPS and S&T maintenance reports • Record sheet showing location and time of occurrence, number of services affected • Geotagged photographs with date
Unplanned congestion in stations due to failure of general power through grid supply for lighting, communication etc	Metro Passengers	• As soon as standby supply is activated, notify OCC and suspend boarding and alighting in affected station; let trains pass through. • Close entry of passengers into affected stations • Switch on battery-powered high-power lamps which have been fixed to stations structure • Use portable hailers to address passengers and employees • Use portable lamps to locate and evacuate passengers and employees.	• Handheld 2 way radios and hailing loudspeakers • Portable handheld lamps • Maintenance equipment, spares and personnel	Notification: CMRL to Emergency Action Committee Remedial Action by: CMRL	• Mock drills	• Standby system maintenance reports • Record sheet showing location and time of occurrence • Geotagged photographs with date

Service disruption, Grievous hurt, loss of life due to natural disasters such as unanticipated earthquakes	Community and Metro Passengers	• Notify Operation Control Centre to suspend operation of trains bound to pass through affected stations or section; stop trains at stations outside affected section • Administer first aid • Notify nearby hospitals for ambulances and to standby • Evacuate trains which have been stopped • Close entry of passengers into affected stations • Switch on battery-powered high-power lamps which have been fixed to station structure • Disconnect grid and standby DG power supply with turnstiles in default open mode. • Use portable hailers to address passengers and employees • Use portable lamps to locate and evacuate passengers and employees.	• Trained rescue teams • Emergency battery fixed lighting • Hand torches • First Aid Kits • Safety helmets • Ropes and safety harnesses • Stretchers • Ladders • Ambulance • Rail-cum-road Vehicles	Notification: CMRL to Emergency Action Committee, hospitals, Police, State Government, Commissioner Metro Rail Safety (CMRS) * Remedial Action by: CMRL	• Mock drills • First Aid • Evacuation • Search and Rescue	• Magnitude and epicenter of earthquake • Seismic design adopted in design of structures • Record sheet showing location and time of occurrence, number of persons affected • Geotagged photographs with date
Unplanned congestion in stations due to terrorism or sabotage or law and order situations on Metro project or outside Metro project	Community, Metro Passengers and employees	• Notify Operation Control Centre to suspend operation of trains bound to pass through affected stations or section; stop trains at stations outside affected section • Administer first aid • Notify nearby hospitals for ambulances and to standby • Evacuate trains which have been stopped • Close entry of passengers into affected stations	• First Aid Kits • Stretchers • Ambulance	Notification: CMRL to Emergency Action Committee, hospitals, Police, State Government Remedial Action by: CMRL		• Record sheet showing location and time of occurrence, number of persons affected • Geotagged photographs with date
Grievous hurt, loss of life and property due to terrorism or				Notification: CMRL to Emergency Action	• Mock drills • First Aid • Evacuation	

sabotage or law and order situations on Metro project		.		Committee, hospitals, Police, State Government, CMRS* Remedial Action by: CMRL	• Search and Rescue	
Acts of suicide or murder or hurt	Perpetrators and victims	• Notify OCC and suspend operation of trains on affected platform; stop trains at stations outside affected section • Administer first aid • Notify nearby hospitals for ambulance and to standby	• First Aid Kits • Stretchers • Ambulance	CMRL to Emergency Action Committee, hospitals, Police, State Government, CMRS* Remedial Action by: CMRL	• Mock drills • First Aid • Evacuation	

***** *Metro Railway (Operations and Maintenance) Act, 2002 requires reporting of a) collision or derailment of trains or b) accidents attended or usually attended by loss of life or grievous hurt*

9.6 Training and Capacity Building Programs

296. CMRL's current capacity in monitoring of metro projects in adequate. However it is proposed to conduct a training program for CMRL as well as general consultant and contractors environmental, health and safety officials particularly on MDBs' monitoring and reporting requirements. External monitor will undertake training and capacity building activities. Training modules will be discussed and confirmed by CMRL and MDBs. A budget has been allocated in the EMP for the same.

9.7 Environmental Management Budget and Resources

297. The cost of all compensation and rehabilitations works will be an integrated part of the overall project cost, which will be borne by the project. The preliminary estimated cost of the environmental and social management plan is estimated as below. This cost estimate is exclusive of land acquisition and resettlement & resettlement cost.

Table 9.5: Cost of EMP and EMoP Implementation

Item	Amount (Rs in lakh)
Compensatory Plantation	57.60
Diversion of Forest Land	34.80
Rainwater Harvesting	574.25
Environmental Monitoring *	411.32
Training	55.94
Environment Division	97.80
Rooftop Solar Plant	1,228.15
COVID-19 measures (lumpsum)	300.00
Total	**2,759.86**

***** *Cost of building condition survey during construction and capital cost of noise barriers will form part of construction cost*

Adequate budget for ecological / biodiversity monitoring, tree transplantation and mitigation measures other than those in Table 9.5 will be allotted by CMRL.

10 CONCLUSION AND RECOMMENDATION

298. The alignment of the proposed Balance C5 is not located in any protected area, except 7,570 sqm in the Nanmangalam Reserved Forest between Velakallu and Medavakkam Koot Road, the forest clearance of alienation of forest land to non-forest use will be required. Careful selection of alignment has avoided sites of historical/cultural significance: impact of proximity of the alignment to Madras War Cemetery will be minimized by mitigation measures.

299. Significant adverse impacts are a) social impacts due to involuntary resettlement, b) loss of trees, climate change effects of continuous increase in ambient temperature, heavy precipitation events, and sea level rise, utility diversion, air, noise, vibration, water demand, disturbance to bird habitat due to construction, c) noise, vibration, disturbance to bird habitat due to operation, and d) ecological impacts are anticipated due to 305 public trees felling along the existing roads, and the alignment sharing the right of way of existing road which is crossing the marshland.

300. Making use of extensive available information, measures to mitigate adverse impacts have been recommended while highlighting worker safety, solar power and rainwater harvesting. Roles and responsibilities of CMRL, General Consultant and the Contractor have been sharply delineated in pre-construction and construction phases.

301. EMP and EMoP have been developed so as to mitigate or minimize significant adverse impacts due to the project. Responsibilities of CMRL and the contractor in securing pre-construction approvals from GoTN.

302. Benefits include reduced air pollution and road accident, increased benefits to economy and commuters on metro and road. Major roads along the proposed alignments are forecast to function beyond respective design service volume in year 2035 in absence of the project lines. BRT has significantly lower unit life cycle cost but road right of way is not adequate to operate BRT on Corridor 5. Therefore continuity of Metro is required. Requirement of acquisition of property was minimized by fine-tuning of locations and footprint of stations.

303. Public consultations highlighted opinions of participants on benefits of Metro in terms of easing connectivity, pollution, congestion, accidents and travel on roads. Public consultations during construction and operation will form part of periodic monitoring reports sent by CMRL to MDBs. These consultations will focus on the efficacy of mitigation measures being implemented.

304. Grievance Redress Mechanism will be developed to assist the citizens, users of the Metro and other stakeholders communicate their queries, complaints and suggestions in connection with implementation of EMP and EMoP. GRM for both workers and communities will be instituted during pre-construction phase to continue through different phases.

305. Institutional arrangement, EMP, reporting and record keeping, emergency response and environment monitoring plan have been developed. Budgetary cost estimate to implement the EMP and EMoP has been prepared.

306. Best available technology and best management practices are built-in to the project design. All project components will be implemented and monitored in line with the MDBs' applicable policies and standards. A semi-annual environmental and social monitoring report will be submitted to MDBs and will be disclosed publicly at the MDBs' websites.

Environmental and social benefits of the project and long-term investment program objectives outweigh the temporary negative impacts.

Annexures

Annexure 1. Sensitive Receptors on Balance C5

Sl. No	Name of the Sensitive Receptors	Location	Type of Sensitive Receptor	LHS/RHS	Distance from the outer most proposed tracks (m)	Latitude	Longitude
1	MASJID FIRDOUSE	**GRAIN MARKET TO SAI NAGAR BUS STOP**	MOSQUE	RHS	65.90	13º03'54.3"N	80°11'51.6"E
2	PERIYAPALATHAMMAN KOVIL	**GRAIN MARKET TO SAI NAGAR BUS STOP**	TEMPLE	RHS	76.50	13º03'53.2"N	80°11'50.4"E
3	KILASEVALPATTI SIVA TEMPLE	**GRAIN MARKET TO SAI NAGAR BUS STOP**	TEMPLE	LHS	99.60	13º03'46.5"N	80°11'53.2"E
4	MARTHOMA MATRICULATION HIGHER SECONDARY SCHOOL	**GRAIN MARKET TO SAI NAGAR BUS STOP**	SCHOOL	RHS	97.52	13º03'44.9"N	80°11'45.2"E
5	SBS HOSPITAL	**GRAIN MARKET TO SAI NAGAR BUS STOP**	HOSPITAL	RHS	52.71	13º03'34.0"N	80°11'40.8"E
6	INFANT JESUS CATHOLIC CHURCH	**SAI NAGAR BUS STOP TO ELANGO NAGAR BUS STOP**	CHURCH	LHS	72.98	13º03'23.6"N	80°11'40.4"E
7	THARACHAND NAGAR PARK	**SAI NAGAR BUS STOP TO ELANGO NAGAR BUS STOP**	PARK	LHS	143.49	13º03'17.6"N	80°11'40.1"E
8	BALALOK MATRIC HIGHER SECONDARY SCHOOL	**SAI NAGAR BUS STOP TO ELANGO NAGAR BUS STOP**	SCHOOL	LHS	177.90	13º03'15.4"N	80°11'39.8"E
9	MASID AYESHA MASQUE	**SAI NAGAR BUS STOP TO ELANGO NAGAR BUS STOP**	MOSQUE	RHS	21.43	13º03'17.1"N	80°11'33.7"E
10	SEVENTH DAY ADVENTIST CHURCH	**SAI NAGAR BUS STOP TO ELANGO NAGAR BUS STOP**	CHURCH	LHS	11.78	13º02'55.1"N	80°11'27.1"E
11	ADVENT CHRISTIAN CHURCH	**SAI NAGAR BUS STOP TO ELANGO NAGAR BUS STOP**	CHURCH	LHS	6.44	13º03"18.6"N	80°11'35.5"E
12	ANNAI HOSPITAL	**SAI NAGAR BUS STOP TO ELANGO NAGAR BUS STOP**	HOSPITAL	LHS	18.92	13º03'14.0"N	80°11'33.7"E
13	NADATHUR AMMAL VARADHAGURU TEMPLE	**SAI NAGAR BUS STOP TO ELANGO NAGAR BUS STOP**	TEMPLE	LHS	95.80	13º03"11.1"N	80°11'35.1"E
14	MM HOSPITAL	**SAI NAGAR BUS STOP TO ELANGO NAGAR BUS STOP**	HOSPITAL	RHS	28.76	13º03'10.1"N	80°11'30.7"E
15	SWATHI CLINIC	**ELANGO NAGAR BUS STOP TO ALWARTHIRU NAGAR**	HOSPITAL	LHS	183.69	13º02'56.1"N	80°11'37.8"E
16	SRI SUNDRS VARATHARAJA PERUMAL TEMPLE	**ELANGO NAGAR BUS STOP TO ALWARTHIRU NAGAR**	TEMPLE	LHS	1.89	13º02'55.5"N	80°11'32.1"E
17	RADHE KRISHNA TEMPLE	**ELANGO NAGAR BUS STOP TO ALWARTHIRU NAGAR**	TEMPLE	LHS	172.97	13º02'54.9"N	80°11'38.0"E

18	ARULMIGU SRI KALIAMMAN TEMPLE	**ELANGO NAGAR BUS STOP TO ALWARTHIRU NAGAR**	TEMPLE	RHS	2.11	13º02'52.3"N	80°11'32.9"E
19	SHRI SAIBABA TEMPLE	**ELANGO NAGAR BUS STOP TO ALWARTHIRU NAGAR**	TEMPLE	RHS	169.11	13º02'51.6"N	80°11'27.3"E
20	SANTHOSHI MADHA TEMPLE	**ELANGO NAGAR BUS STOP TO ALWARTHIRU NAGAR**	TEMPLE	LHS	74.50	13º02'48.3"N	80°11'33.7"E
21	SUBAM SPECIALITIES HOSPITAL	**ELANGO NAGAR BUS STOP TO ALWARTHIRU NAGAR**	HOSPITAL	RHS	49.69	13º02'49.0"N	80°11'21.8"E
22	SRI AMMAN TEMPLE	**ELANGO NAGAR BUS STOP TO ALWARTHIRU NAGAR**	TEMPLE	LHS	122.76	13º02'43.1"N	80°11'20.5"E
23	VEMBULIAMMAN TEMPLE	**ELANGO NAGAR BUS STOP TO ALWARTHIRU NAGAR**	TEMPLE	LHS	15.21	13º02'47.0"N	80°11'21.6"E
24	CHENNAI MANAGARACHI SERUVAR PARK	**ELANGO NAGAR BUS STOP TO ALWARTHIRU NAGAR**	PARK	LHS	17.85	13º02'42.0"N	80°11'23.0"E
25	CSI CHRIST CHURCH	**ELANGO NAGAR BUS STOP TO ALWARTHIRU NAGAR**	CHURCH	LHS	40.73	13º02'44.7"N	80°11'17.3"E
26	KIRUBASANAM CHURCH OF CHRIST	**ELANGO NAGAR BUS STOP TO ALWARTHIRU NAGAR**	CHURCH	RHS	139.87	13º02'55.1"N	80°11'27.1"E
27	Masjid E-Muhammad	**PORUR TO MUGALIVAKKAM**	Mosque	LHS	7.98	13°02'10.1"N	80°09'29.7"E
28	Parvathy Hospital	**PORUR TO MUGALIVAKKAM**	Hospital	LHS	62.00	13°02'11.5"N	80°09'23.6"E
29	Masjidhul Ahad	**PORUR TO MUGALIVAKKAM**	Mosque	LHS	187.00	13°02'05.3"N	80°09'15.5"E
30	SMK Jain Sthamak	**PORUR TO MUGALIVAKKAM**	Temple	LHS	145.50	13°02'02.0"N	80°09'17.4"E
31	Sivaloga Sivan Adiya Kootam	**PORUR TO MUGALIVAKKAM**	Temple	LHS	139.40	13°01'59.2"N	80°09'19.1"E
32	Balamurugan Temple	**PORUR TO MUGALIVAKKAM**	Temple	LHS	187.28	13°01'57.0"N	80°09'18.9"E
33	Siva Veera Anjaneya Temple	**PORUR TO MUGALIVAKKAM**	Temple	RHS	199.00	13°02'00.2"N	80°09'31.6"E
34	P.K Hospital	**PORUR TO MUGALIVAKKAM**	Hospital	RHS	72.00	13°02'03.0"N	80°09'25.6"E
35	Uragappu Perumal Temple	**PORUR TO MUGALIVAKKAM**	Temple	RHS	53.00	13°02'03.1"N	80°09'24.1"E
36	Vairakya Anjaneyar	**PORUR TO MUGALIVAKKAM**	Temple	RHS	195.70	13°02'08.8"N	80°09'39.0"E
37	Ayyappan Temple	**PORUR TO MUGALIVAKKAM**	Temple	RHS	40.30	13°02'04.2"N	80°09'37.3"E
38	St. Johns Matric Hr. Sec. School	**PORUR TO MUGALIVAKKAM**	School	RHS	123.00	13°02'07.3"N	80°09'38.6"E
39	Arulmigu Sri Muthumariamman Temple	**PORUR TO MUGALIVAKKAM**	Temple	RHS	27.00	13°02'01.5"N	80°09'25.4"E
40	St. Joseph's Church	**PORUR TO MUGALIVAKKAM**	Church	LHS	132.16	13°01'57.8"N	80°09'31.1"E
41	Sri Vigneshwara Temple	**PORUR TO MUGALIVAKKAM**	Temple	LHS	87.85	13°01'58.7"N	80°09'29.7"E

42	Sri Divya Devi Mandir	**PORUR TO MUGALIVAKKAM**	Temple	LHS	54.30	13°02'00.1"N	80°09'30.1"E
43	Govt. Boys School	**PORUR TO MUGALIVAKKAM**	School	LHS	46.03	13°02'01.8"N	80°09'36.0"E
44	ECI First Church Porur	**PORUR TO MUGALIVAKKAM**	Church	LHS	20.72	13°02'01.8"N	80°09'36.9"E
45	The Salvation Army Porur Tamil Cops	**PORUR TO MUGALIVAKKAM**	Church	LHS	76.15	13°01'59.9"N	80°09'37.3"E
46	DMI St. Joseph Hospital	**PORUR TO MUGALIVAKKAM**	Hospital	LHS	52.50	13°01'59.2"N	80°09'40.0"E
47	Mosque	**PORUR TO MUGALIVAKKAM**	Mosque	RHS	47.96	13°02'03.1"N	80°09'39.9"E
48	Vinayaga Shrine	**MUGALIVAKKAM TO DLF IT SEZ**	Temple	LHS	2.32	13°01'56.2"N	80°09'50.8"E
49	New Creation Covenant Church	**MUGALIVAKKAM TO DLF IT SEZ**	Church	RHS	24.22	13°01'56.0"N	80°09'48.0"E
50	Sethu Kshetram	**MUGALIVAKKAM TO DLF IT SEZ**	Temple	LHS	28.00	13°01'49.0"N	80°10'04.0"E
51	Puthu Koyil	**MUGALIVAKKAM TO DLF IT SEZ**	Temple	LHS	85.64	13°01'44.9"N	80°10'15.0"E
52	Karumariamman Temple	**MUGALIVAKKAM TO DLF IT SEZ**	Temple	LHS	78.50	13°01'44.9"N	80°10'14.6"E
53	Shri Vinayagar Temple	**MUGALIVAKKAM TO DLF IT SEZ**	Temple	LHS	51.07	13°01'42.9"N	80°10'16.4"E
54	Nagathamman Koyil	**MUGALIVAKKAM TO DLF IT SEZ**	Temple	LHS	193.00	13°01'45.9"N	80°10'20.4"E
55	Husainy High School	**MUGALIVAKKAM TO DLF IT SEZ**	School	LHS	28.60	13°01'40.9"N	80°10'18.6"E
56	Sabari Nagar Thavamaiyam	**MUGALIVAKKAM TO DLF IT SEZ**	Temple	RHS	156.00	13°01'37.8"N	80°10'11.6"E
57	Sri Ayyappan Temple	**MUGALIVAKKAM TO DLF IT SEZ**	Temple	RHS	193.00	13°01'36.4"N	80°10'11.6"E
58	Shekinah Abundant Life Church	**DLF IT SEZ TO SATHYA NAGAR**	Church	LHS	17.90	13°01'33.7"N	80°10'30.6"E
59	Krishtu Jothi Church	**DLF IT SEZ TO SATHYA NAGAR**	Church	LHS	60.20	13°01'24.4"N	80°10'50.3"E
60	MGR Garden	**DLF IT SEZ TO SATHYA NAGAR**	Memorial Garden	LHS	61.86	13°01'22.3"N	80°10'54.2"E
61	Sri Putru Amman Koyil	**SATHYA NAGAR TO CTC**	Temple	LHS	129.35	13°01'21.0"N	80°11'00.7"E
62	Murali Hospital	**SATHYA NAGAR TO CTC**	Hospital	LHS	178.44	13°01'21.8"N	80°11'02.5"E
63	MIOT Hospital	**SATHYA NAGAR TO CTC**	Hospital	LHS	123.56	13°01'17.8"N	80°11'08.0"E
64	Vinayaga Teple	**SATHYA NAGAR TO CTC**	Temple	LHS	87.68	13°01'10.4"N	80°11'14.4"E
65	Arulmigu Angala Parameswari Temple	**SATHYA NAGAR TO CTC**	Temple	RHS	40.34	13°01'05.0"N	80°11'12.7"E
66	Global Christian Church	**SATHYA NAGAR TO CTC**	Church	LHS	6.63	13°01'03.2"N	80°11'17.2"E
67	Sivan Temple	**SATHYA NAGAR TO CTC**	Temple	RHS	148.51	13°00'57.7"N	80°11'16.3"E

68	Arulmigu Kothandaramar Temple	**SATHYA NAGAR TO CTC**	Temple	LHS	149.73	13°01'02.3"N	80°11'28.5"E
69	Temple	**CTC TO ST. WESLEY CHURCH**	Temple	LHS	68.62	13°00'59.2"N	80°11'28.6"E
70	Vinayagar Temple	**CTC TO ST. WESLEY CHURCH**	Temple	LHS	68.13	13°00'56.4"N	80°11'33.7"E
71	ESI Hospital	**CTC TO ST. WESLEY CHURCH**	Hospital	LHS	70.20	13°00'55.4"N	80°11'35.7"E
72	Global Christian Church	**CTC TO ST. WESLEY CHURCH**	Church	RHS	90.00	13°00'51.8"N	80°11'31.1"E
73	Madras War Cemetry	**CTC TO ST. WESLEY CHURCH**	Cemetry	LHS	6.80	13°00'50.7"N	80°11'37.9"E
74	Nagathamman Koyil	**CTC TO ST. WESLEY CHURCH**	Temple	LHS	95.00	13°00'48.4"N	80°11'42.8"E
75	Amman Temple	**CTC TO ST. WESLEY CHURCH**	Temple	LHS	20.30	13°00'47.0"N	80°11'40.7"E
76	Contonement Board High School	**CTC TO ST. WESLEY CHURCH**	School	LHS	77.93	13°00'46.5"N	80°11'43.3"E
77	Christ English School	**CTC TO ST. WESLEY CHURCH**	School	RHS	72.83	13°00'45.0"N	80°11'38.3"E
78	St. Joseph College	**CTC TO ST. WESLEY CHURCH**	College	RHS	39.00	13°00'48.9"N	80°11'37.2"E
79	St. Joseph's Matric. Hr. Sec. School	**CTC TO ST. WESLEY CHURCH**	School	RHS	173.55	13°00'40.8"N	80°11'37.1"E
80	St. Thomas Hospital	**CTC TO ST. WESLEY CHURCH**	Hospital	LHS	110.22	13°00'43.3"N	80°11'46.4"E
81	St, Thomas Garrison Church Cemetry	**CTC TO ST. WESLEY CHURCH**	Cemetry	LHS	149.84	13°00'46.7"N	80°11'46.0"E
82	Military Hospital	**CTC TO ST. WESLEY CHURCH**	Hospital	RHS	102.75	13°00'41.9"N	80°11'39.1"E
83	Sri Velli Selva Prasanna Vinayagar Koyil	**CTC TO ST. WESLEY CHURCH**	Temple	LHS	146.35	13°00'39.1"N	80°11'49.7"E
84	St Thomas Church, Kerala RCSC Malayalam	**CTC TO ST. WESLEY CHURCH**	Church	LHS	139.29	13°00'37.7"N	80°11'49.6"E
85	Sri Angala Parameswari Amman Alayam	**CTC TO ST. WESLEY CHURCH**	Temple	LHS	29.00	13°00'35.1"N	80°11'46.0"E
86	Contonement Board General Hospital	**CTC TO ST. WESLEY CHURCH**	Hospital	RHS	79.00	13°00'34.8"N	80°11'42.4"E
87	Butt Road Masjid	**CTC TO ST. WESLEY CHURCH**	Mosque	RHS	8.00	13°00'32.8"N	80°11'45.3"E
88	Ruskin's School	**CTC TO ST. WESLEY CHURCH**	School	LHS	20.37	13°00'32.4"N	80°11'47.3"E
89	Marian School	**CTC TO ST. WESLEY CHURCH**	School	RHS	89.94	13°00'30.5"N	80°11'43.9"E
90	St. Patricks's Church	**CTC TO ST. WESLEY CHURCH**	Church	RHS	136.50	13°00'29.3"N	80°11'43.0"E
91	Marian Primary School	**CTC TO ST. WESLEY CHURCH**	School	RHS	114.87	13°00'29.1"N	80°11'44.2"E
92	CSI Wesley Church	**CTC TO ST. WESLEY CHURCH**	Church	RHS	151.50	13°00'27.4"N	80°11'44.5"E
93	JMJ Convent	**CTC TO ST. WESLEY CHURCH**	Church	RHS	190.37	13°00'25.6"N	80°11'45.3"E

94	St. Helen Girls Hr. Sec. School	**CTC TO ST. WESLEY CHURCH**	School	RHS	175.50	13°00'25.4"N	80°11'48.9"E
95	New Vision Bethesda Church	**ST. WESLEY CHURCH TO ALANDUR**	Church	LHS	178.50	13°00'36.8"N	80°11'51.2"E
96	Arulmigu Sri Kasi Viswanadar Alayam	**ST. WESLEY CHURCH TO ALANDUR**	Temple	LHS	15.60	13°00'31.7"N	80°11'52.7"E
97	CSI St. Thomas Matric Hr. Sec. School	**ST. WESLEY CHURCH TO ALANDUR**	School	RHS	102.00	13°00'27.8"N	80°11'52.1"E
98	Bright Light Ministries	**ST. WESLEY CHURCH TO ALANDUR**	Church	RHS	145.13	13°00'26.4"N	80°11'52.1"E
99	Tamil Westley Church CSI	**ST. WESLEY CHURCH TO ALANDUR**	Church	RHS	49.70	13°00'29.6"N	80°11'57.5"E
100	Arulmigu Sri Bala Vinayagar	**ST. WESLEY CHURCH TO ALANDUR**	Temple	LHS	109.20	13°00'34.9"N	80°12'03.2"E
101	National Matric. Hr. Sec. School	**ST. WESLEY CHURCH TO ALANDUR**	School	LHS	56.00	13°00'32.3"N	80°12'14.7"E
102	Raadha Rajendran Hospital	**ST. WESLEY CHURCH TO ALANDUR**	Hospital	LHS	97.00	13°00'20.9"N	80°12'15.3"E
103	Hindustan Institute of Engg. & Tech.	**ST. WESLEY CHURCH TO ALANDUR**	College	RHS	107.32	13°00'23.7"N	80°12'08.1"E
104	Hindustan InternationalSchool CAIE	**ST. WESLEY CHURCH TO ALANDUR**	School	RHS	102.50	13°00'23.0"N	80°12'07.4"E
105	Sri Prasanna Venkatesa Perumal Temple	**ST. WESLEY CHURCH TO ALANDUR**	Temple	LHS	106.30	13°00'19.6"N	80°12'14.3"E
106	Sivan Koyil	**ST. WESLEY CHURCH TO ALANDUR**	Temple	LHS	134.00	13°00'17.6"N	80°12'13.0"E
107	Arulmigu Tirpura Sundari temple	**ST. WESLEY CHURCH TO ALANDUR**	Temple	LHS	150.15	13°00'16.8"N	80°12'13.0"E
108	Sri Prasanna Venkatesa Sami Temple	**ST. WESLEY CHURCH TO ALANDUR**	Temple	LHS	146.30	13°00'16.7"N	80°12'12.5"E
109	Sri Kothanda Ramar Sannidhi	**ST. WESLEY CHURCH TO ALANDUR**	Temple	LHS	147.62	13°00'16.4"N	80°12'12.5"E
110	Vinayagar Koyil	**ALANDUR TO ST. THOMBAS MRTS**	Temple	LHS	135.90	13°00'12.9"N	80°12'10.4"E
111	Arulmigu Sri Nagathamman Alayam	**ALANDUR TO ST. THOMBAS MRTS**	Temple	RHS	34.90	13°00'09.7"N	80°12'03.0"E
112	Battle Ground	**ALANDUR TO ST. THOMBAS MRTS**	Historic Landmark	RHS	116.40	13°00'14.1"N	80°12'01.8"E
113	Elite School of Optometry	**ALANDUR TO ST. THOMBAS MRTS**	College & Hospital	RHS	32.90	13°00'03.9"N	80°12'00.5"E
114	Navanitha Salini Alayam	**ALANDUR TO ST. THOMBAS MRTS**	Temple	RHS	141.26	13°00'03.5"N	80°11'56.8"E
115	Salaf Council Mosque	**ALANDUR TO ST. THOMBAS MRTS**	Mosque	LHS	198.32	13°00'02.3"N	80°12'07.9"E
116	Monfort Higher Secondary School	**ALANDUR TO ST. THOMBAS MRTS**	School	LHS	119.35	13°00'02.6"N	80°12'05.4"E
117	St. Antony's Church	**ALANDUR TO ST. THOMBAS MRTS**	Church	LHS	22.50	13°00'00.1"N	80°12'02.1"E

118	Masjid-E-Azeemjahi Golandazi	**ALANDUR TO ST. THOMBAS MRTS**	Mosque	LHS	109.03	12°59'58.3"N	80°12'05.0"E
119	Masjid E Ahle Hadees Alandur	**ALANDUR TO ST. THOMBAS MRTS**	Mosque	LHS	155.64	12°59'55.4"N	80°12'06.6"E
120	Arulmigu Sri Padaveettu Amman Koyil	**ALANDUR TO ST. THOMBAS MRTS**	Temple	RHS	11.00	12°59'51.8"N	80°12'01.4"E
121	Madha Church	**ALANDUR TO ST. THOMBAS MRTS**	Church	RHS	57.24	12°59'51.6"N	80°11'59.8"E
122	Nesarin Karam Church	**ALANDUR TO ST. THOMBAS MRTS**	Church	RHS	38.29	12°59'50.5"N	80°12'00.6"E
123	Vinayagar Temple	**ALANDUR TO ST. THOMBAS MRTS**	Temple	RHS	30.34	12°59'49.9"N	80°12'00.9"E
124	Indra Gandhi Matriculation School	**ALANDUR TO ST. THOMBAS MRTS**	School	LHS	197.29	12°59'44.4"N	80°12'07.1"E
125	Grama Devadai Palandi Amman Temple	**ALANDUR TO ST. THOMBAS MRTS**	Temple	LHS	140.24	12°59'42.8"N	80°12'03.3"E
126	Lord Nandheeswarar Temple	**ALANDUR TO ST. THOMBAS MRTS**	Temple	LHS	167.34	12°59'40.8"N	80°12'01.7"E
127	Bringi Munivarukku Nandhiroobama Temple	**ALANDUR TO ST. THOMBAS MRTS**	Temple	LHS	188.00	12°59'40.7"N	80°12'02.6"E
128	Ganesh Institute of Engineering	**ST. THOMBAS MRTS TO ADAMBAKKAM MRTS**	College	LHS	151.64	12°59'37.6"N	80°11'51.5"E
129	Vinayagar Temple	**ST. THOMBAS MRTS TO ADAMBAKKAM MRTS**	Temple	RHS	73.26	12°59'39.2"N	80°11'43.3"E
130	Adambakkam Christian Assembly	**ST. THOMBAS MRTS TO ADAMBAKKAM MRTS**	Church	LHS	9.80	12°59'30.7"N	80°11'44.2"E
131	Right Choice Sms	**ST. THOMBAS MRTS TO ADAMBAKKAM MRTS**	Church	LHS	157.45	12°59'26.2"N	80°11'49.3"E
132	Shri Selva Gajamugan Aalayam Temple	**ST. THOMBAS MRTS TO ADAMBAKKAM MRTS**	Temple	LHS	115.04	12°59'19.9"N	80°11'47.9"E
133	Devi Karumariamman Temple	**ST. THOMBAS MRTS TO ADAMBAKKAM MRTS**	Temple	RHS	37.34	12°59'20.2"N	80°11'42.9"E
134	Lakshmi Narasimar Temple	**ST. THOMBAS MRTS TO ADAMBAKKAM MRTS**	Temple	RHS	67.73	12°59'20.5"N	80°11'41.9"E
135	Shirdi Sai Baba Temple	**ST. THOMBAS MRTS TO ADAMBAKKAM MRTS**	Temple	RHS	156.35	12°59'19.9"N	80°11'38.9"E
136	Arogyakshamaday Sai Baba Temple	**ADAMBAKKAM MRTS TO MEDAVAKKAM MAIN ROAD**	Temple	LHS	96.88	12°59'09.1"N	80°11'50.1"E
137	Ayyappan Temple	**ADAMBAKKAM MRTS TO MEDAVAKKAM MAIN ROAD**	Temple	RHS	86.42	12°59'09.7"N	80°11'43.7"E
138	Sri Angala Parameshwari Amman Temple	**ADAMBAKKAM MRTS TO MEDAVAKKAM MAIN ROAD**	Temple	RHS	63.70	12°59'06.2"N	80°11'44.9"E
139	Sri LakshmiNarayana Perumal Temple	**ADAMBAKKAM MRTS TO MEDAVAKKAM MAIN ROAD**	Temple	RHS	74.45	12°59'06.1"N	80°11'44.5"E
140	Sri Varasakthi Vinayagar	**ADAMBAKKAM MRTS TO MEDAVAKKAM MAIN ROAD**	Temple	RHS	84.89	12°59'03.5"N	80°11'44.2"E

141	Aanandha Vinayagar Temple	**ADAMBAKKAM MRTS TO MEDAVAKKAM MAIN ROAD**	Temple	RHS	75.93	12°58'59.6"N	80°11'44.4"E
142	Sri Venkatesa Perumal Temple	**ADAMBAKKAM MRTS TO MEDAVAKKAM MAIN ROAD**	Temple	RHS	6.94	12°58'58.7"N	80°11'46.5"E
143	KALPANA HOSPITAL	**ADAMBAKKAM MRTS TO MEDAVAKKAM MAIN ROAD**	Hospital	LHS	1.00	12°58'57.4"N	80°11'46.3"E
144	Palandi Amman Temple	**ADAMBAKKAM MRTS TO MEDAVAKKAM MAIN ROAD**	Temple	LHS	111.45	12°58'53.4"N	80°11'48.3"E
145	St.Jude's Shrine	**ADAMBAKKAM MRTS TO MEDAVAKKAM MAIN ROAD**	Church	LHS	19.37	12°58'53.5"N	80°11'44.9"E
146	The Pison Ministries	**MEDAVAKKAM MAIN ROAD TO IBACO**	Church	LHS	166.73	12°58'48.6"N	80°11'47.9"E
147	Sri Vembuli Amman Temple	**MEDAVAKKAM MAIN ROAD TO IBACO**	Temple	LHS	47.17	12°58'48.3"N	80°11'43.3"E
148	Noorul Hudha Masjid	**MEDAVAKKAM MAIN ROAD TO IBACO**	Mosque	RHS	134.61	12°58'49.9"N	80°11'37.3"E
149	Amman Temple	**MEDAVAKKAM MAIN ROAD TO IBACO**	Temple	RHS	1.20	12°58'48.0"N	80°11'41.2"E
150	Draubathi Amman Temple	**MEDAVAKKAM MAIN ROAD TO IBACO**	Temple	RHS	11.07	12°58'47.7"N	80°11'40.7"E
151	Ebenezer Evangelical Church	**MEDAVAKKAM MAIN ROAD TO IBACO**	Church	RHS	173.35	12°58'49.7"N	80°11'35.8"E
152	Zion PM Church	**MEDAVAKKAM MAIN ROAD TO IBACO**	Church	LHS	107.53	12°58'41.9"N	80°11'41.6"E
153	CSI St. James Church	**MEDAVAKKAM MAIN ROAD TO IBACO**	Church	LHS	16.87	12°58'41.5"N	80°11'38.5"E
154	Amman Temple	**MEDAVAKKAM MAIN ROAD TO IBACO**	Temple	LHS	1.12	12°58'38.1"N	80°11'37.3"E
155	AG church (Glad Tidings)	**IBACO TO MADIPAKKAM KOOT ROAD BUS STOP**	Church	LHS	87.37	12°58'21.2"N	80°11'32.2"E
156	Amman Temple	**IBACO TO MADIPAKKAM KOOT ROAD BUS STOP**	Temple	RHS	172.44	12°58'28.8"N	80°11'26.0"E
157	Prarthanalaya	**IBACO TO MADIPAKKAM KOOT ROAD BUS STOP**	Church	RHS	21.35	12°58'20.3"N	80°11'28.0"E
158	Gideon's Army of Worship Centre	**IBACO TO MADIPAKKAM KOOT ROAD BUS STOP**	Church	LHS	1.47	12°58'16.8"N	80°11'27.3"E
159	Murugan Temple	**IBACO TO MADIPAKKAM KOOT ROAD BUS STOP**	Temple	LHS	2.59	12°58'14.1"N	80°11'26.2"E
160	Jain Temple	**IBACO TO MADIPAKKAM KOOT ROAD BUS STOP**	Temple	LHS	16.67	12°58'12.2"N	80°11'25.9"E
161	Pathala Vigneswarar Temple	**IBACO TO MADIPAKKAM KOOT ROAD BUS STOP**	Temple	RHS	5.83	12°58'15.9"N	80°11'26.7"E
162	Bathala vinayagar kovil	**IBACO TO MADIPAKKAM KOOT ROAD BUS STOP**	Temple	RHS	46.00	12°58'14.2"N	80°11'24.5"E
163	Temple	**IBACO TO MADIPAKKAM KOOT ROAD BUS STOP**	Temple	RHS	178.34	12°58'16.1"N	80°11'20.5"E
164	Sibi Hospital	**IBACO TO MADIPAKKAM KOOT ROAD BUS STOP**	Hospital	LHS	23.24	12°58'11.3"N	80°11'25.7"E

165	Shri Aayee Mataji Mandir	**IBACO TO MADIPAKKAM KOOT ROAD BUS STOP**	Temple	RHS	38.39	12°58'12.0"N	80°11'23.8"E
166	Sai Matriculation Higher Secondary School	**IBACO TO MADIPAKKAM KOOT ROAD BUS STOP**	School	LHS	185.00	12°58'05.4"N	80°11'29.0"E
167	Masjid-E-Hameem	**IBACO TO MADIPAKKAM KOOT ROAD BUS STOP**	Mosque	RHS	120.50	12°58'07.2"N	80°11'18.6"E
168	Kalaimagal Vidhya Mandhir Matric. School	**IBACO TO MADIPAKKAM KOOT ROAD BUS STOP**	School	RHS	147.00	12°58'05.7"N	80°11'17.0"E
169	Anjakha Hospital	**MADIPAKKAM KOOT ROAD BUS STOP TO VENKATESWARA NAGAR**	Hospital	LHS	11.00	12°57'50.1"N	80°11'16.5"E
170	Divya Hospital	**MADIPAKKAM KOOT ROAD BUS STOP TO VENKATESWARA NAGAR**	Hospital	RHS	9.00	12°57'51.7"N	80°11'16.3"E
171	Ganesh Temple	**MADIPAKKAM KOOT ROAD BUS STOP TO VENKATESWARA NAGAR**	Temple	RHS	47.30	12°57'49.8"N	80°11'14.4"E
172	Shirdi Shri Bhairava Sai Baba tem	**MADIPAKKAM KOOT ROAD BUS STOP TO VENKATESWARA NAGAR**	Temple	RHS	81.87	12°57'48.8"N	80°11'13.0"E
173	Our Lady Of Lourdes Church	**MADIPAKKAM KOOT ROAD BUS STOP TO VENKATESWARA NAGAR**	Church	LHS	190.67	12°57'42.7"N	80°11'21.0"E
174	Shri Selva Vinayagar Aalayam	**MADIPAKKAM KOOT ROAD BUS STOP TO VENKATESWARA NAGAR**	Temple	LHS	135.96	12°57'35.6"N	80°11'17.9"E
175	Holy family school	**MADIPAKKAM KOOT ROAD BUS STOP TO VENKATESWARA NAGAR**	School	RHS	50.23	12°57'37.1"N	80°11'11.9"E
176	Temple	**MADIPAKKAM KOOT ROAD BUS STOP TO VENKATESWARA NAGAR**	Temple	RHS	161.78	12°57'35.6"N	80°11'08.0"E
177	Ravindra Bharti Global School	**VENKATESWARANAGAR-ECHANKADU BUS STOP**	School	LHS	42.64	12°57'06.1"N	80°11'08.5"E
178	Shri Sapthakannimar Temple	**VENKATESWARANAGAR-ECHANKADU BUS STOP**	Temple	RHS	96.67	12°57'12.4"N	80°11'14.8"E
179	Grace Hospital	**VENKATESWARANAGAR-ECHANKADU BUS STOP**	Hospital	RHS	196.49	12°57'17.9"N	80°11'19.0"E
180	Vinayagar Temple	**ECHANKADU BUS STOP-KOVILAMBIKAM BUS STOP**	Temple	RHS	41.24	12°57'01.6"N	80°11'09.5"E
181	CSI Nalmaiper Church	**KOVILAMBIKAM BUS STOP-VELAKALLU BUS STOP**	church	LHS	126.34	12°56'26.3"N	80°10'53.5"E
182	Vinayagar Temple		Temple	RHS	83.79	12°56'10.4"N	80°10'59.3"E
183	Arun Hospital		Hospital	RHS	61.07	12°56'27.3"N	80°10'58.2"E
184	sri Muthumariamman Alayam	**VELAKALLU BUS STOP-MEDAVAKKAM KOOT ROAD BUS STOP**	Temple	LHS	65.49	12° 55' 58.3104" N	80°10 48.6" E
185	V.S Hospital	**VELAKALLU BUS STOP-MEDAVAKKAM KOOT ROAD BUS STOP**	Hospital	LHS	184.32	12° 56' 2.148" N	80°10'52.1" E
186	Makkah Masjid	**VELAKALLU BUS STOP-MEDAVAKKAM KOOT ROAD BUS STOP**	Mosque	RHS	33.48	12° 55' 43.4964" N	80°10'52.1" E
187	Srivarasidhi vinayagar kovil	**VELAKALLU BUS STOP-MEDAVAKKAM KOOT ROAD BUS STOP**	Temple	RHS	23.05	12° 55' 52.2768" N	80°10'54.2" E

188	Sri Baktha Anjanayar temple	**VELAKALLU BUS STOP-MEDAVAKKAM KOOT ROAD BUS STOP**	Temple	RHS	19.77	12° 55' 23.88" N	80°10'59.2" E
189	Quaide Millath College	**MEDAVAKKAM KOOT ROAD BUS STOP-KAMARAJ GARDEN**	College	LHS	185.41	12°55'14.9"N	80°10'54.8"E
190	Hindu Temple	**MEDAVAKKAM KOOT ROAD BUS STOP-KAMARAJ GARDEN**	Temple	LHS	122.62	12° 55' 10.6" N	80°11'00.8"E
191	Vinayagar Temple	**MEDAVAKKAM KOOT ROAD BUS STOP-KAMARAJ GARDEN**	Temple	LHS	184.30	12° 55' 7.6" N	80°11'02.5"E
192	Perumal	**MEDAVAKKAM KOOT ROAD BUS STOP-KAMARAJ GARDEN**	Temple	LHS	184.40	12° 55' 7.1112" N	80°11'08.5"E
193	Seedplayschool	**MEDAVAKKAM KOOT ROAD BUS STOP-KAMARAJ GARDEN**	School	RHS	158.07	12°55'19.3"N	80°11'05.6"E
194	The Christ Matriculation school	**MEDAVAKKAM KOOT ROAD BUS STOP-KAMARAJ GARDEN**	School	RHS	167.90	12°55'17.3"N	80°11'12.9"E
195	Annai Therasa Hospitals Pvt Ltd	**MEDAVAKKAM KOOT ROAD BUS STOP-KAMARAJ GARDEN**	Hospital	RHS	89.36	12°55'06.4"N	80°11'20.9"E
196	Primary Health Care	**KAMARAJ GARDEN-MEDAVAKKAM BUS STOP**	Hospital	LHS	189.03	12°54'51.7"N	80°11'34.5"E
197	Vidhya Matric High Sec. School	**KAMARAJ GARDEN-MEDAVAKKAM BUS STOP**	School	RHS	98.04	12°54'45.8"N	80°11'45.5"E
198	Masjid-e-Muhammadhiya	**KAMARAJ GARDEN-MEDAVAKKAM BUS STOP**	Mosque	LHS	24.09	12°54'46.2"N	80°11'41.4"E
199	Renuka Parameswari Amman Temple	**KAMARAJ GARDEN-MEDAVAKKAM BUS STOP**	Temple	RHS	142.61	12°54'45.7"N	80°11'46.4"E
200	Masjide Ayesha	**MEDAVAKKAM BUS STOP-PERUMBAKKAM BUS STOP**	Mosque	LHS	115.12	12°54'26.2"N	80°11'51.5"E
201	Samithoppu Sri Vaigundar Ayya Temple	**MEDAVAKKAM BUS STOP-PERUMBAKKAM BUS STOP**	Temple	LHS	23.16	12°54'29.4"N	80°11'52.6"E
203	Perumbakkam Advent Christian Church	**PERUMBAKKAM BUS STOP-GLOBAL HOSPITAL**	Chruch	LHS	34.91	12°54'26.2"N	80°12'00.9"E
204	St Gregorios Jacobite Syrian Orthodox Church	**PERUMBAKKAM BUS STOP-GLOBAL HOSPITAL**	Chruch	LHS	151.41	12°54'20.4"N	80°12'14.9"E
205	Angala Parameshwari Temple	**PERUMBAKKAM BUS STOP-GLOBAL HOSPITAL**	Temple	RHS	24.07	12°54'27.5"N	80°12'06.6"E
206	Bharathi Vidyalaya Senior Secondary School	**PERUMBAKKAM BUS STOP-GLOBAL HOSPITAL**	School	RHS	101.08	12°54'30.9"N	80°12'13.2"E
207	Panjamuga Vinayagar Temple	**PERUMBAKKAM BUS STOP-GLOBAL HOSPITAL**	Temple	RHS	76.75	12°54'27.3"N	80°12'18.3"E
208	Maranatha Calvary Telugu Church	**GLOBAL HOSPITAL- HCL ELCOT**	Church	LHS	200.00	12°54'11.6"N	80°12'18.5"E
209	LLM church - LifeLine Ministries	**GLOBAL HOSPITAL- HCL ELCOT**	Church	LHS	64.43	12°54'19.7"N	80°12'23.6"E
210	Central Institute of Classical Tamil	**GLOBAL HOSPITAL- HCL ELCOT**	college	RHS	73.09	12°54'17.8"N	80°12'39.7"E
211	Shri Shirdi Selva Sai Baba Mandir	**HCL ELCOT**	Temple	RHS	126.40	12°54'09.2"N	80°13'25.8"E

212	Living Spring English Church	**HCL ELCOT**	Church	RHS	201.60	12°54'04.5"N	80°13'34.8"E
213	Masjid-ur-Rahman		Mosque	RHS	96.06	12°54'06.4"N	80°13'23.7"E

Annexure 2. CMRL and MRTS Coordination Plan

Date: 23.10.2020

Sub: Construction of CMRL & MRTS structures along the common alignment after St. Thomas Mount Metro station from Ch.31300 to Ch. 31700 (CMRL chainage).

******

Southern Railways and CMRL agreed to take up their structures constructed within the same ROW available with MRTS for the above section which enables utilizing the same ROW. The works of CMRL will also be executed by Southern Railway as a deposit work.

To have a closer association and review the works and to ensure timely completion as per the specifications etc., it is agreed to have a joint meeting by CMRL and MTP/Southern Railways every quarter after the commencement of works. The review will be made on the following aspects.

1. Work progress visa vis., the timelines
2. Review the quality documents
3. Review the safety and environmental issues.
4. Finalization of as built documents at the end of the project.
5. Sharing the documents for the purpose of CMRL for their portion of work for submission to CMRS.

(Thiru M. Ilampooranan)
CE /CN/Central/ MS,
Southern Railways

(S. Ashok Kumar)
General Manager (T &EC) 23/X/20
CMRL

MTP, Southern Railways

Annexure 3. Acceptable Vibration Impact Criteria

Table 8-1. Ground-Borne Vibration (GBV) and Ground-Borne Noise (GBN) Impact Criteria for General Assessment

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

Notes:

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

(Transit Noise and Vibration Impact Assessment, FTA, May 2006)

Vibration Category 3 - Institutional: Vibration Category 3 includes schools, churches, other institutions, and quiet offices that do not have vibration-sensitive equipment, but still have the potential for activity interference.

Acceptable Vibration Impact Criteria

(Metro Rail Transit System Guidelines for Noise and vibrations, RDSO India, Sept 2015)

Table 3.7. Ground-Borne Vibration (GBV) and Ground-Borne Noise (GBN) Impact Criteria for General Assessment

Land Use Category	GBV Impact Levels (VdB ref 25.4 micro-mm /sec)			GBN Impact Levels (dB ref 20 micro Pascals)		
	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]	Frequent Events[1]	Occasional Events[2]	Infrequent Events[3]
Category 1: Buildings where vibration would interfere with interior operations.	65 VdB4	65 VdB4	65 VdB4	N/A4	N/A4	N/A4
Category 2: Residences and buildings where people normally sleep	72 VdB	75 VdB	80 VdB	35 dBA	38 dBA	43 dBA
Category 3: Institutional land uses with primarily daytime use.	75 VdB	78 VdB	83 VdB	40 dBA	43 dBA	48 dBA

Notes:

1. " Frequent Events" is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
2. "Occasional Events" is defined as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.
3. "Infrequent Events" is defined as fewer than 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.
4. This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration-sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the HVAC systems and stiffened floors.
5. Vibration sensitive equipment is generally not sensitive to ground-borne noise. DIN 4150-2 can also be referred for guidelines values for evaluating human exposure to vibration in dwellings and similar spaces.

Annexure 4. Affected Utilities

Sewage pipelines

104	5	31000	33600	2600	LHS	1.2M DIA	BGL-2.5M	PARALLEL	U/G	YES
105	5	33600	34500	900	RHS	1.2M DIA	BGL-2.5M	PARALLEL	U/G	YES
106	5	31430	31430	30	CROSSING(LHS)	0.4M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
107	5	31950	31950	30	CROSSING(LHS)	0.4M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
108	5	32650	32650	30	CROSSING(LHS)	0.4M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
109	5	33000	33000	30	CROSSING(LHS)	0.4M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
110	5	33750	33750	30	CROSSING(RHS)	0.4M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
111	5	33820	33820	30	CROSSING(RHS)	0.4M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
112	5	34020	34020	30	CROSSING(RHS)	0.4M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
113	5	34180	34180	30	CROSSING(LHS)	0.4M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
114	5	34180	34180	30	CROSSING(RHS)	0.4M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
115	5	39400	39400	30	CROSSING(LHS)	1.6M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
116	5	39400	41100	1700	LHS	1.6M DIA	BGL-2.5M	PARALLEL	U/G	YES

Water pipelines

S. No	Corridor	From Ch. (m)	To Ch. (m)	Affected Length (M)	LHS/RHS	Dia/Size	Depth (BGL in m)	Position from Alignment	Metro Alignment	Diversion required
60	5	14660	14660	30	CROSSING(RHS)	0.5M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
61	5	15140	15140	30	CROSSING(LHS)	0.3M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
62	5	27850	27850	30	CROSSING(LHS)	1.0M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
63	5	27850	27850	30	CROSSING(RHS)	1.0M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
64	5	29000	29000	30	CROSSING(LHS)	1.0M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
65	5	29000	29200	200	LHS	1.0M DIA	BGL-2.5M	PARALLEL	U/G	YES
66	5	30970	30970	30	CROSSING(LHS)	1.0M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
67	5	30970	44200	13230	LHS	1.0M DIA	BGL-2.5M	PARALLEL	U/G	YES
68	5	31430	31430	30	CROSSING(LHS)	0.6M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
69	5	32050	32050	30	CROSSING(RHS)	0.3M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
70	5	32520	32520	30	CROSSING(RHS)	0.3M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
71	5	33050	33050	30	CROSSING(LHS)	0.3M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
72	5	34180	34180	30	CROSSING(RHS)	0.6M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
73	5	34950	34950	30	CROSSING(LHS)	1.5M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
74	5	37350	37350	30	CROSSING(LHS)	0.5M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
75	5	39550	39550	30	CROSSING(RHS)	0.6M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
76	5	40980	40980	30	CROSSING(RHS)	0.3M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
77	5	41870	41870	30	CROSSING(RHS)	0.2M DIA	BGL-2.5M	PERPENDICULAR	U/G	NO
78	5	43450	43450	30	CROSSING(RHS)	0.6M DIA	BGL-2.5M	PERPENDICULAR	ELEVATED	YES
79	5	43450	44200	750	RHS	0.6M DIA	BGL-2.5M	PARALLEL	ELEVATED	YES

A large number of Telecommunication cables of various providers

Above ground electric lines

48	LT LINE	25163	25163	CROSSING(RHS)	PERPENDICULAR	6.6KV
49	LT LINE	26100	26100	CROSSING(LHS)	PERPENDICULAR	440V
50	LT LINE	26100	26520	LHS	PARALLEL	440V
51	LT LINE	26520	26520	CROSSING(LHS)	PERPENDICULAR	440V
52	LT LINE	26740	26740	CROSSING(LHS)	PERPENDICULAR	6.6KV
53	LT LINE	26740	27040	LHS	PARALLEL	6.6KV

54	LT LINE	27040	27040	CROSSING(LHS)	PERPENDICULAR	6.6KV
55	LT LINE	28570	28570	CROSSING(LHS)	PERPENDICULAR	440V
56	LT LINE	28570	29010	LHS	PARALLEL	440V
57	LT LINE	29010	29010	CROSSING(LHS)	PERPENDICULAR	440V
58	LT LINE	30970	30970	CROSSING(LHS)	PERPENDICULAR	11KV
59	LT LINE	30970	31430	LHS	PARALLEL	11KV
60	LT LINE	31430	31430	CROSSING(LHS)	PERPENDICULAR	11KV
61	LT LINE	31960	31960	CROSSING(LHS)	PERPENDICULAR	11KV
62	LT LINE	31960	34190	LHS	PARALLEL	11KV
63	LT LINE	34190	34190	CROSSING(LHS)	PERPENDICULAR	11KV
64	HT LINE	34950	34950	CROSSING(LHS)	PERPENDICULAR	33KV
65	HT LINE	34950	34950	CROSSING(RHS)	PERPENDICULAR	33KV
66	LT LINE	35690	35690	CROSSING(LHS)	PERPENDICULAR	6.6KV
67	LT LINE	35690	36240	LHS	PARALLEL	6.6KV
68	LT LINE	36240	36240	CROSSING(LHS)	PERPENDICULAR	6.6KV
69	LT LINE	36500	36500	CROSSING(LHS)	PERPENDICULAR	6.6KV
70	LT LINE	36500	37630	LHS	PARALLEL	6.6KV
71	LT LINE	37630	37630	CROSSING(LHS)	PERPENDICULAR	6.6KV
72	LT LINE	39240	39240	CROSSING(LHS)	PERPENDICULAR	6.6KV
73	LT LINE	39240	39400	LHS	PARALLEL	6.6KV
74	LT LINE	39400	39400	CROSSING(LHS)	PERPENDICULAR	6.6KV
75	LT LINE	39400	39400	CROSSING(RHS)	PERPENDICULAR	6.6KV
76	LT LINE	39920	39920	CROSSING(LHS)	PERPENDICULAR	6.6KV
77	LT LINE	39920	41100	LHS	PARALLEL	6.6KV
78	HT LINE	41100	41100	CROSSING(LHS)	PERPENDICULAR	33KV
79	HT LINE	41100	42700	LHS	PARALLEL	33KV
80	HT LINE	42700	42700	CROSSING(LHS)	PERPENDICULAR	33KV
81	LT LINE	43270	43270	CROSSING(LHS)	PERPENDICULAR	6.6KV
82	LT LINE	43270	44224	LHS	PARALLEL	6.6KV

Annexure 5
Terms of Reference of General Consultant in Implementation of EMP and EMoP

i. Review and update EIA including EMP and EMoP as appropriate; incorporate necessary technical specifications following design and contract documentation;
ii. Assist CMRL in preparation of documents and taking necessary procedures in accordance with in the EIA Report for the Project, if any;
iii. Assist CMRL in dissemination and explanation of additionally confirmed and identified environmental issues to public including holding public consultations;
iv. Assist CMRL in obtaining necessary permits from relevant authorities and/or departments in accordance with the planned implementation schedule stated in the EIA Report;
v. During the preparation of bidding documents, clearly include environmental responsibilities as explained in the EIA Report and EMP as "Environmental Contract Specifications (ECS)";
vi. Ensure that designs and construction methods provide for, as per the EMP, environment-friendly building materials, reuse, resource saving and climate adaptation elements like natural ventilation, solar power installations and rain water harvesting; piling methods and track design which minimize noise and vibration;
vii. Ensure the primary baseline data of environmental elements are in place prior to mobilization;
viii. Assist CMRL in reviewing the Contractor's Environmental Program (CEP) to be prepared by the contractor in accordance with EIA, EMP, ECC (Environmental Compliance Certificate) and ECS, relevant plans, conditions set out in relevant permits and clearances and Funding Agencies' Environmental Policy and to make recommendations to CMRL regarding any necessary amendments for its approval;
ix. Assist CMRL to implement the measures identified in the EMP;
x. Monitor the effectiveness of EMP and negative impacts on environment caused by the construction works and provide technical advice, including a feasible solution, so that CMRL can carry out improvement when necessary;
xi. Monitor compliance with the requirements under EMP and Funding Agencies' Environmental Policy. Submit the Environmental Monitoring Report to CMRL at every month after the commencement of the services until the completion of the Project. After the completion of the Project, the Report will be submitted **semiannually for two (2) years**. The Environmental Monitoring as per Funding Agencies E&S templates will be filled and attached to the Report;
xii. After verifying the Environmental Monitoring Report by CMRL, assist submitting the report to Funding Agencies as part of the Progress Status Report at every **three months** after the commencement of the services until the completion of the Project and **semiannually for two (2) years**

after the completion of the Project;

xiii. Assist CMRL in preparation of the answer to the request from Funding Agencies for environmental considerations if necessary;

xiv. Assist CMRL in facilitating stakeholder's participation (including focus group discussions for vulnerable PAPs) and providing feedbacks on their comments regarding EMP and EMoP;

xv. Supervise Contractor's activities to check compliance with CEP and prepare periodic monitoring reports;

xvi. Assist CMRL to establish a multi-layer Grievance Redress Mechanism (GRM) including Grievance Redress Committee (GRC) to resolve the Grievances of environment, health and safety matters in a timely manner;

xvii. Assist CMRL in the capacity building of CMRL staff on environmental management through on-the-job training on environmental assessment techniques, mitigation measure planning and implementation, supervision and monitoring, and reporting;

xviii. At the completion of project, (a) undertake final environmental monitoring and evaluation against the set indicators, (b) evaluate sustainability of environmental benefits associated with the project, taking into account both positive and negative impacts associated with the project, and (c) prepare an evaluation report for the project;

Annexure 6
Terms of Reference for External Monitoring Agency/Expert

Background

1. **Project Description.** The Chennai Metro Corridor 5 from CMBT to Sholinganallur 30.125km is all elevated with 29 stations.

2. **Project Category.** The Project is assigned as category A for Environment and Involuntary Resettlement as the project is likely to have significant adverse environment and social (E&S) impacts. Chennai Metro Rail Limited (CMRL) will retain external monitor to conduct the third party monitoring and verify the monitoring information submitted by General Consultant (GC).

Objective(s) of the Assignment

3. To conduct third party monitoring of implementation of the E&S requirements under the project;

4. To ensure that the Project will be implemented in conformity with the policies of Government of India (GoI), Government of Tamil Nadu (GoTN), as well as the lenders' E&S policies; and

5. To identify any environment and social related implementation issues and necessary corrective actions and reflect these in a time-bound corrective action plan for CMRL to implement.

6. Capturing social, environmental and economic benefits and particular potential benefits to the poor and vulnerable groups in the corridor;

7. Involving users and stakeholders in the monitoring process; and

8. Strengthening the capacity of the CMRL to manage and replicate third-party monitoring with rail users and stakeholders

Scope of Services, Tasks and Expected Deliverables

9. **Scope of Services.** Monitor the implementation of the Environmental Management Plan (EMP), Resettlement Action Plan (RAP), Gender Action Plan (GAP), Vulnerable Communities Plan (VCP) / Indigenous Peoples Development Plan (IPDP) as applicable and monitoring activities by the respective contractors and supervision consultants. Provide technical guidance and feedback to the respective contractors and supervision consultants. Monitor operational stage and residual impacts during project implementation.

10. **The Tasks** include but not limited to the following,

    1) Review the Social Impact Assessment with a focus on (RAP), and the Environmental Impact Assessment (EIA) with a focus on EMP;

    2) Review the Environmental, Health and Safety clauses included in the civil works contract agreement;

    3) Review the internal E&S monitoring reports;

4) Undertake independent field inspections to verify the implementation of RAP GAP, VCP / IPDP and consult community and affected people;

5) Review the Grievances register logs at project sites;

6) Visit the project sites, oversee quantitative environmental monitoring activities of CMRL to confirm appropriate methodologies being used and results correctly interpreted, and consult potentially affected people about the environmental nuisances;

7) Randomly interview the labors about health and safety compliance;

8) Assess EMP implementation performance, qualitatively or by conducting additional quantitative environmental monitoring as required;

9) Discuss findings of assessment with CMRL and provide recommendations to resolve any issues or problems on implementing EMP RAP, GAP and VCP / IPDP;;

10) Prepare the external E&S monitoring reports, which should confirm the project's compliance with the EMP, RAP GAP, VCP / IPDP, and reflect in the time-bound corrective action plan for any non-compliances;

Deliverables. The following are the key outputs expected from the consultants:

11. External SMP monitoring reports:
    a. Once upon payment of compensation and entitlements
    b. Implementation of livelihood restoration and its efficacy: semi annually during construction stage
    c. Implementation of gender action plan and its efficacy: annually during first 2 years of operation and maintenance

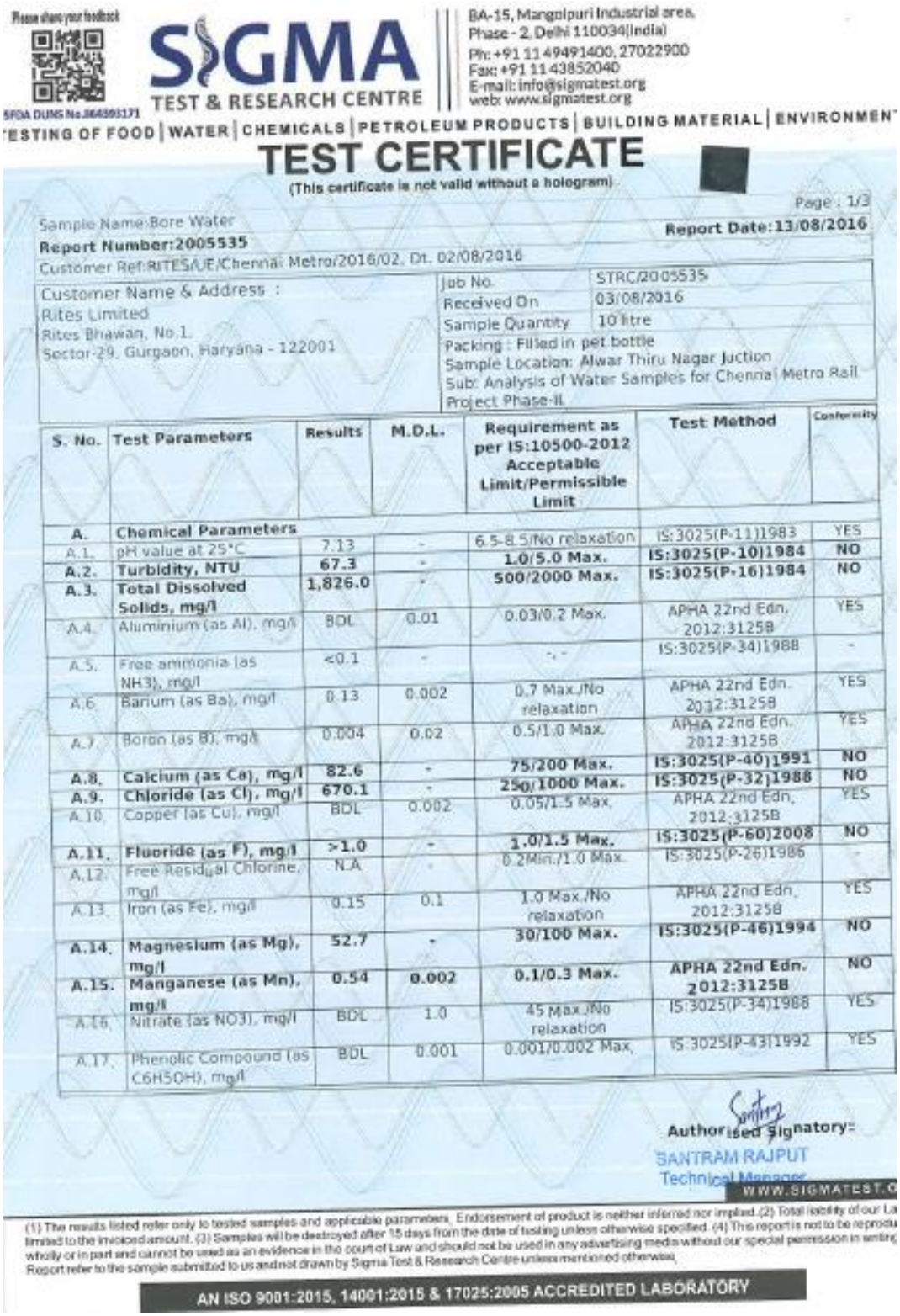
12. External EMP monitoring reports:
    d. Implementation of EMP, EMoP, Grievance Redressal and their efficacy: semi-annual during construction stage
    e. Implementation of EMP, EMoP, Grievance Redressal and their efficacy: annually during operation & maintenance during first 2 years of operation and maintenance.

Team Composition & Qualification Requirements

13. One environmental expert and one social expert would be required with E&S related disciplines and with at least 10 years of work experience in E&S management of linear projects, preferably in transport sector.
14. Total estimated man-days for both experts during construction stage: (25 person x day / report) x (2 reports / year) x 4 years = 200 person x day.
15. Total estimated man-days during O&M stage: (20-person x day / report) x (1 report / year) x 2 years = 40-person x day.

Annexure 7. Laboratory Data of the Water, Air, Noise and Soil

7-1. Water



Please share your feedback

SIGMA TEST & RESEARCH CENTRE

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Page : 1/3

Sample Name:Bore Water

Report Number:2005535 **Report Date:13/08/2016**

Customer Ref:RITES/UE/Chennai Metro/2016/02, Dt. 02/08/2016

Customer Name & Address :
Rites Limited
Rites Bhawan, No.1,
Sector-29, Gurgaon, Haryana - 122001

Job No. STRC/2005535
Received On 03/08/2016
Sample Quantity 10 litre
Packing : Filled in pet bottle
Sample Location: Alwar Thiru Nagar Juction
Sub: Analysis of Water Samples for Chennai Metro Rail Project Phase-II.

S. No.	Test Parameters	Results	M.D.L.	Requirement as per IS:10500-2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
A.	**Chemical Parameters**					
A.1.	pH value at 25°C	7.13	-	6.5-8.5/No relaxation	IS:3025(P-11)1983	YES
A.2.	**Turbidity, NTU**	**67.3**	-	**1.0/5.0 Max.**	**IS:3025(P-10)1984**	**NO**
A.3.	**Total Dissolved Solids, mg/l**	**1,826.0**	-	**500/2000 Max.**	**IS:3025(P-16)1984**	**NO**
A.4.	Aluminium (as Al), mg/l	BDL	0.01	0.03/0.2 Max.	APHA 22nd Edn. 2012:3125B	YES
A.5.	Free ammonia (as NH3), mg/l	<0.1	-	-,-	IS:3025(P-34)1988	-
A.6.	Barium (as Ba), mg/l	0.13	0.002	0.7 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.7.	Boron (as B), mg/l	0.004	0.02	0.5/1.0 Max.	APHA 22nd Edn. 2012:3125B	YES
A.8.	**Calcium (as Ca), mg/l**	**82.6**	-	**75/200 Max.**	**IS:3025(P-40)1991**	**NO**
A.9.	**Chloride (as Cl), mg/l**	**670.1**	-	**250/1000 Max.**	**IS:3025(P-32)1988**	**NO**
A.10.	Copper (as Cu), mg/l	BDL	0.002	0.05/1.5 Max.	APHA 22nd Edn. 2012:3125B	YES
A.11.	**Fluoride (as F), mg/l**	**>1.0**	-	**1.0/1.5 Max.**	**IS:3025(P-60)2008**	**NO**
A.12.	Free Residual Chlorine, mg/l	N.A	-	0.2Min./1.0 Max.	IS:3025(P-26)1986	-
A.13.	Iron (as Fe), mg/l	0.15	0.1	1.0 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.14.	**Magnesium (as Mg), mg/l**	**52.7**	-	**30/100 Max.**	**IS:3025(P-46)1994**	**NO**
A.15.	**Manganese (as Mn), mg/l**	**0.54**	**0.002**	**0.1/0.3 Max.**	**APHA 22nd Edn. 2012:3125B**	**NO**
A.16.	Nitrate (as NO3), mg/l	BDL	1.0	45 Max./No relaxation	IS:3025(P-34)1988	YES
A.17.	Phenolic Compound (as C6H5OH), mg/l	BDL	0.001	0.001/0.002 Max.	IS:3025(P-43)1992	YES

Authorised Signatory:
SANTRAM RAJPUT
Technical Manager

WWW.SIGMATEST.C

(1) The results listed refer only to tested samples and applicable parameters. Endorsement of product is neither inferred nor implied.(2) Total liability of our La limited to the invoiced amount. (3) Samples will be destroyed after 15 days from the date of testing unless otherwise specified. (4) This report is not to be reproduc wholly or in part and cannot be used as an evidence in the court of Law and should not be used in any advertising media without our special permission in writing Report refer to the sample submitted to us and not drawn by Sigma Test & Research Centre unless mentioned otherwise.

AN ISO 9001:2015, 14001:2015 & 17025:2005 ACCREDITED LABORATORY

Please share your feedback
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TEST CERTIFICATE

(This certificate is not valid without a hologram)

Sample Name:Bore Water — **Report Date:13/08/2016**

Report Number:2005535

Customer Ref:RITES/UE/Chennai Metro/2016/02, Dt. 02/08/2016

S. No.	Test Parameters	Results	M.D.L.	Requirement as per IS:10500-2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
A.18.	Selenium (as Se), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.19.	Silver (as Ag), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.20.	Sulphate (as SO4), mg/l	46.1	5.0	200/400 Max.	IS:3025(P-24)1986	YES
A.21.	Sulphide (as S), mg/l	BDL	0.05	0.05 max./No relaxation	IS:3025(P-29)1986	YES
A.22.	**Total alkalinity (as CaCO3), mg/l**	**460.6**	**-**	**200/600 Max.**	**IS:3025(P-23)1986**	**NO**
A.23.	**Total Hardness (as CaCo3), mg/l**	**422.3**	**-**	**200/600 Max.**	**IS:3025(P-21)2009**	**NO**
A.24.	Zinc (as Zn), mg/l	BDL	0.02	5.0/15.0 Max.	APHA 22nd Edn. 2012:3125B	YES
A.25.	Cadmium (as Cd), mg/l	BDL	0.002	0.003 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.26.	Cyanide (as CN), mg/l	BDL	0.02	0.05 Max./No relaxation	IS:3025(P-27)1986	YES
A.27.	Lead (as Pb), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.28.	**Mercury (as Hg), mg/l**	**0.006**	**0.0002**	**0.001 Max./No relaxation**	**APHA 22nd Edn. 2012:3125B**	**NO**
A.29.	Nickel (as Ni), mg/l	BDL	0.002	0.02 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.30.	Total Arsenic (as As), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.31.	Total Chromium (as Cr), mg/l	BDL	0.002	0.05 max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.32.	Total suspended solids, mg/l	21.0	-	-, -	IS:3025(P-17)1984	-
A.33.	Vanadium (as V), mg/l	BDL	0.002	-, -	APHA 22nd Edn. 2012:3125B	-
A.34.	Ammonical Nitrogen (as N)	<0.1	-	0.5 max./No relaxation	IS:3025(P-34)1988	YES
A.35.	Total kjeldahl nitrogen (as N)	0.2	-	-, -	IS:3025(P-34)1988	-
A.36.	Chromium (as hexavalent chromium), mg/l	BDL	0.1	-, -	IS:3025(P-52)2003	-

Authorised Signatory:
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Technical Manager

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TEST CERTIFICATE

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Sample Name:Bore Water
Report Date:13/08/2016
Report Number:2005535
Customer Ref:RITES/UE/Chennai Metro/2016/02, Dt. 02/08/2016

S. No.	Test Parameters	Results	M.D.L.	Requirement as per IS:10500-2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
A.37.	Oil & Grease, mg/l	<1.0	-	-,-	IS:3025(P-39)1991	-
A.38.	Dissolved oxygen, mg/l	4.6	-	-,-	IS:3025(P-38)1989	-
A.39.	Chemical oxygen demand, mg/l	64.0	-	-,-	IS:3025(P-58)2006	-
A.40.	Biochemical oxygen demand, mg/l	23.0	-		IS:3025(P-44)1993	-
A.41.	Total phosphate, mg/l	0.9	0.1	-,-	IS:3025(P-31)1988	-
A.42.	Dissolved phosphate (as P), mg/l	0.9	0.1	-,-	IS:3025(P-31)1988	-
A.43.	Sodium (as Na), mg/l	575.0	2.0	-,-	IS:3025(P-45)1993	-
A.44.	Potassium (as K), mg/l	15.0	2.0	-,-	IS:3025(P-45)1993	-
A.45.	Nitrate nitrogen, mg/l	BDL	0.2	-,-	IS:3025(P-34)1988	-
A.46.	Total nitrogen, mg/l	0.2	-	-,-	IS:3025(P-34)1988	-
A.47.	Organic phosphorus, mg/l	BDL	0.00001	-,-	USEPA 8141 A	-
B.	**Microbiological Examination**					
B.1.	Coliform count, MPN/100ml	<1	-	Shall not be detectable in any 100ml, sample	IS:1622-1981	Yes
B.2.	Faecal coliform, MPN/100ml	<1	-	-,-	IS:1622-1981	-
B.3.	Total coliform organism, cfu/100ml	<1	-	-,-	IS:1622-1981	-

Remarks : Protocol:- IS: 10500-2012 for Acceptable limit/Permissible limit.
Note:- According to IS:10500-2012 ,it is recommended that the acceptable limit is to be implemented. Values greater than the acceptable limits render the water is not suitable, but still may be tolerated in the absence of an alternate source but upto permissible limits.
BDL = Below detection limit, MDL = Method detection limit.

***** End of Report *****

Authorised Signatory:
SANTOSH SINGH
Technical Manager

Please share your feedback

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TC-5369

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Sample : Drinking Water	**Report Number:2009361**
Sample Description :Said to be "Ground Water (Bore-Well)"	Report Issue Date: 28/05/2018
Customer Ref:RITES/UE/CHENNAI METRO-C4/2018, 16/05/2018	Page : 1/4

Customer Name & Address : Rites Limited Rites Bhawan, No.1, Sector-29, Gurgaon, Haryana - 122001 Agreement Number: -	Job code	STRC/2009361
	Sample received on	16/05/2018
	Date of Testing	16/05/2018-28/05/2018
	Sample Quantity	10 litre
	Sample condition: Filled in PET bottle Sample Location: Polur Juction	

Name of Work:Chennai Metro, C4 Extension Project.

S. No.	Test Parameters	Test Results	M.D.L.	Requirements As Per IS:10500:2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
A.	**Chemical Parameters**					
A.1.	pH value at 25°C	6.62	-	6.5-8.5/No relaxation	IS:3025(P-11)1983	Yes
A.2.	Turbidity, NTU	<0.1	-	1.0/5.0 Max.	IS:3025(P-10)1984	Yes
A.3.	**Total Dissolved Solids, mg/l**	**675.0**	**-**	**500/2000 Max.**	**IS:3025(P-16)1984**	**No**
A.4.	Aluminium (as Al), mg/l	BDL	0.01	0.03/0.2 Max.	APHA 23rd Edn. 2017:3125B	Yes
A.5.	Free ammonia* (as NH3), mg/l	<0.1	-	-	IS:3025(P-34)1988	-
A.6.	Barium (as Ba), mg/l	BDL	0.002	0.7 Max./No relaxation	APHA 23rd Edn. 2017:3125B	Yes
A.7.	Boron (as B), mg/l	BDL	0.02	0.5/1.0 Max.	APHA 23rd Edn. 2017:3125B	Yes
A.8.	**Calcium (as Ca), mg/l**	**76.2**	**-**	**75/200 Max.**	**IS:3025(P-40)1991**	**No**
A.9.	Chloride (as Cl), mg/l	123.2	-	250/1000 Max.	IS:3025(P-32)1988	Yes
A.10.	Copper (as Cu), mg/l	BDL	0.002	0.05/1.5 Max.	APHA 23rd Edn. 2017:3125B	Yes
A.11.	**Fluoride (as F), mg/l**	**>1.0**	**-**	**1.0/1.5 Max.**	**IS:3025(P-60)2008**	**No**
A.12.	Free Residual Chlorine, mg/l	N.A.	-	0.2Min./1.0 Max.	IS:3025(P-26)1986	-
A.13.	Iron (as Fe), mg/l	BDL	0.1	1.0 Max./No relaxation	APHA 23rd Edn. 2017:3125B	Yes
A.14.	Magnesium (as Mg), mg/l	19.5	-	30/100 Max.	IS:3025(P-46)1994	Yes

Santram Rajput
Technical manager

Format No.: STRC/5.10/F/TC05/11

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DIA DUNS No.864393171

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Sample : Drinking Water — **Report Number:2009361**

Sample Description : Said to be "Ground Water (Bore-Well)" — Report Issue Date: 28/05/2018

Customer Ref:RITES/UE/CHENNAI METRO-C4/2018, 16/05/2018 — Page : 2/4

S. No.	Test Parameters	Test Results	M.D.L.	Requirements As Per IS:10500:2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
A.15.	Manganese (as Mn), mg/l	BDL	0.002	0.1/0.3 Max.	APHA 23rd Edn. 2017:3125B	Yes
A.16.	Nitrate (as NO_3), mg/l	21.6	1.0	45 Max./No relaxation	IS:3025(P-34)1988	Yes
A.17.	Phenolic Compound (as C_6H_5OH), mg/l	BDL	0.001	0.001/0.002 Max.	IS:3025(P-43)1992	Yes
A.18.	Selenium (as Se), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 23rd Edn. 2017:3125B	Yes
A.19.	Silver (as Ag), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 23rd Edn. 2017:3125B	Yes
A.20.	Sulphate (as SO_4), mg/l	50.8	5.0	200/400 Max.	IS:3025(P-24)1986	Yes
A.21.	Sulphide* (as S), mg/l	BDL	0.05	0.05 max./No relaxation	IS:3025(P-29)1986	Yes
A.22.	**Total alkalinity (as $CaCO_3$), mg/l**	**310.0**	-	**200/600 Max.**	**IS:3025(P-23)1986**	**No**
A.23.	**Total Hardness (as $CaCO_3$), mg/l**	**270.0**	-	**200/600 Max.**	**IS:3025(P-21)2009**	**No**
A.24.	Zinc (as Zn), mg/l	BDL	0.02	5.0/15.0 Max.	APHA 23rd Edn. 2017:3125B	Yes
A.25.	Cadmium (as Cd), mg/l	BDL	0.002	0.003 Max./No relaxation	APHA 23rd Edn. 2017:3125B	Yes
A.26.	Cyanide (as CN), mg/l	BDL	0.02	0.05 Max./No relaxation	IS:3025(P-27)1986	Yes
A.27.	Lead (as Pb), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 23rd Edn. 2017:3125B	Yes
A.28.	Mercury (as Hg), mg/l	0.00093	0.0002	0.001 Max./No relaxation	APHA 23rd Edn. 2017:3125B	Yes
A.29.	Nickel (as Ni), mg/l	BDL	0.002	0.02 Max./No relaxation	APHA 23rd Edn. 2017:3125B	Yes
A.30.	Total Arsenic (as As), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 23rd Edn. 2017:3125B	Yes

Santram Rajput
Technical manager

Format No.: STRC/5.10/FTC/2/11

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Sample : Drinking Water	**Report Number:2009361**
Sample Description : Said to be "Ground Water (Bore-Well)"	Report Issue Date: 28/05/2018
Customer Ref: RITES/UE/CHENNAI METRO-C4/2018, 16/05/2018	Page : 3/4

S. No.	Test Parameters	Test Results	M.D.L.	Requirements As Per IS:10500:2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
A.31.	Total Chromium (as Cr), mg/l	BDL	0.002	0.05 max./No relaxation	APHA 23rd Edn. 2017:3125B	Yes
A.32.	Total suspended solids, mg/l	7.0	-	--	IS:3025(P-17)1984	-
A.33.	Vanadium* (as V), mg/l	BDL	0.002	--	APHA 23rd Edn. 2017:3125B	-
A.34.	Ammonical Nitrogen* (as N), mg/l	<0.1	-	0.5 max./No relaxation	IS:3025(P-34)1988	Yes
A.35.	Total kjeldahl nitrogen* (as N), mg	27.8	0.03	--	IS:3025(P-34)1988	-
A.36.	Chromium* (as hexavalent chromium), mg/l	BDL	0.1	--	IS:3025(P-52)2003	-
A.37.	Oil & Grease, mg/l	<5.0	-	--	IS:3025(P-39)1991	-
A.38.	Dissolved oxygen, mg/l	6.6	-	--	IS:3025(P-38)1989	-
A.39.	Chemical oxygen demand, mg/l	16.0	-	--	IS:3025(P-58)2006	-
A.40.	Biochemical oxygen demand, mg/l	6.0	-	--	IS:3025(P-44)1993	-
A.41.	Total phosphate*, mg/l	1.3	0.1	--	IS:3025(P-31)1988	-
A.42.	Dissolved phosphate* (as P), mg/l	1.3	0.1	--	IS:3025(P-31)1988	-
A.43.	Sodium (as Na), mg/l	110.0	2.0	--	IS:3025(P-45)1993	-
A.44.	Potassium (as K), mg/l	24.3	2.0	--	IS:3025(P-45)1993	-
A.45.	Nitrate nitrogen*, mg/l	4.9	0.2	--	IS:3025(P-34)1988	-
A.46.	Total nitrogen*, mg/l	27.8	0.03	--	IS:3025(P-34)1988	-
A.47.	Organic phosphorus*, mg/l	BDL	0.00001	--	USEPA 8141 A	-

Ashok Sharma
Technical Manager

Santram Rajput
Technical manager

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Sample : Drinking Water — **Report Number:2009361**

Sample Description :Said to be "Ground Water (Bore-Well)" — Report Issue Date: 28/05/2018

Customer Ref:RITES/UE/CHENNAI METRO-C4/2018, 16/05/2018 — Page : 4/4

S. No.	Test Parameters	Test Results	M.D.L.	Requirements As Per IS:10500:2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
B.	**Microbiological Examination**					
B.1.	**Coliform count, MPN/100ml**	**40**	**-**	**Shall not be detectable in any 100ml. sample**	**IS:1622-1981**	**No**
B.2.	Faecal coliform*, MPN/100ml	10	-	--	IS:1622-1981	-
B.3.	Total coliform organism*, cfu/100ml	80	-	--	IS:1622-1981	-

Note: According to IS:10500-2012, it is recommended that the acceptable limit is to be implemented. Values greater than the acceptable limits render the water is not suitable, but still may be tolerated in the absence of an alternate source but upto permissible limits.

- BDL = Below detection limit, MDL = Method detection limit. N.A=Not Applicable
- The parameter marked with an * are not accredited by NABL.

***** End of Report *****

Ashit Tyagi

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TEST CERTIFICATE

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Sample Name:Bore Water

Report Number:2005534 **Report Date:13/08/2016**

Customer Ref:RITES/UE/Chennai Metro/2016/02, Dt. 02/08/2016

Customer Name & Address : Rites Limited, Rites Bhawan, No.1, Sector-29, Gurgaon, Haryana - 122001	Job No. STRC/2005534
	Received On 03/08/2016
	Sample Quantity 10 ltre
	Packing : Filled in pet bottle
	Sample Location: MIOT Hospital
	Sub: Analysis of Water Samples for Chennai Metro Rail Project Phase-II.

S. No.	Test Parameters	Results	M.D.L.	Requirement as per IS:10500-2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
A.	**Chemical Parameters**					
A.1.	pH value at 25°C	7.82	-	6.5-8.5/No relaxation	IS:3025(P-11)1983	YES
A.2.	Turbidity, NTU	<0.1	-	1.0/5.0 Max.	IS:3025(P-10)1984	YES
A.3.	**Total Dissolved Solids, mg/l**	**1,528.0**	-	**500/2000 Max.**	**IS:3025(P-16)1984**	**NO**
A.4.	Aluminium (as Al), mg/l	BDL	0.01	0.03/0.2 Max.	APHA 22nd Edn. 2012:3125B	YES
A.5.	Free ammonia (as NH3), mg/l	<0.1	-	-, -	IS:3025(P-34)1988	-
A.6.	Barium (as Ba), mg/l	0.146	0.002	0.7 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.7.	Boron (as B), mg/l	BDL	0.02	0.5/1.0 Max.	APHA 22nd Edn. 2012:3125B	YES
A.8.	**Calcium (as Ca), mg/l**	**210.5**	-	**75/200 Max.**	**IS:3025(P-40)1991**	**NO**
A.9.	**Chloride (as Cl), mg/l**	**310.4**	-	**250/1000 Max.**	**IS:3025(P-32)1988**	**NO**
A.10.	Copper (as Cu), mg/l	BDL	0.002	0.05/1.5 Max.	APHA 22nd Edn. 2012:3125B	YES
A.11.	**Fluoride (as F), mg/l**	**>1.0**	-	**1.0/1.5 Max.**	**IS:3025(P-60)2008**	**NO**
A.12.	Free Residual Chlorine, mg/l	N.A	-	0.2Min./1.0 Max.	IS:3025(P-26)1986	-
A.13.	Iron (as Fe), mg/l	BDL	0.1	1.0 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.14.	**Magnesium (as Mg), mg/l**	**32.6**	-	**30/100 Max.**	**IS:3025(P-46)1994**	**NO**
A.15.	Manganese (as Mn), mg/l	0.02	0.002	0.1/0.3 Max.	APHA 22nd Edn. 2012:3125B	YES
A.16.	Nitrate (as NO3), mg/l	9.5	1.0	45 Max./No relaxation	IS:3025(P-34)1988	YES
A.17.	Phenolic Compound (as C6H5OH), mg/l	BDL	0.001	0.001/0.002 Max.	IS:3025(P-43)1992	YES

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Sample Name:Bore Water
Report Number:2005534
Report Date:13/08/2016
Customer Ref:RITES/UE/Chennai Metro/2016/02, Dt. 02/08/2016

S. No.	Test Parameters	Results	M.D.L.	Requirement as per IS:10500-2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
A.18.	Selenium (as Se), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.19.	Silver (as Ag), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.20.	Sulphate (as SO4), mg/l	158.2	5.0	200/400 Max.	IS:3025(P-24)1986	YES
A.21.	Sulphide (as S), mg/l	BDL	0.05	0.05 max./No relaxation	IS:3025(P-29)1986	YES
A.22.	**Total alkalinity (as CaCO3), mg/l**	**411.6**	-	**200/600 Max.**	**IS:3025(P-23)1986**	**NO**
A.23.	**Total Hardness (as CaCo3), mg/l**	**659.2**	-	**200/600 Max.**	**IS:3025(P-21)2009**	**NO**
A.24.	Zinc (as Zn), mg/l	0.032	0.02	5.0/15.0 Max.	APHA 22nd Edn. 2012:3125B	YES
A.25.	Cadmium (as Cd), mg/l	BDL	0.002	0.003 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.26.	Cyanide (as CN), mg/l	BDL	0.02	0.05 Max./No relaxation	IS:3025(P-27)1986	YES
A.27.	Lead (as Pb), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.28.	**Mercury (as Hg), mg/l**	**0.006**	**0.0002**	**0.001 Max./No relaxation**	**APHA 22nd Edn. 2012:3125B**	**NO**
A.29.	Nickel (as Ni), mg/l	BDL	0.002	0.02 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.30.	Total Arsenic (as As), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.31.	Total Chromium (as Cr), mg/l	BDL	0.002	0.05 max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.32.	Total suspended solids, mg/l	5.0	-	-,-	IS:3025(P-17)1984	-
A.33.	Vanadium (as V), mg/l	BDL	0.002	-,-	APHA 22nd Edn. 2012:3125B	-
A.34.	Ammonical Nitrogen (as N)	<0.1	-	0.5 max./No relaxation	IS:3025(P-34)1988	YES
A.35.	Total kjeldahl nitrogen (as N)	11.8	-	-,-	IS:3025(P-34)1988	-
A.36.	Chromium (as hexavalent chromium), mg/l	BDL	0.1	-,-	IS:3025(P-52)2003	-

Authorised Signatory:
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Technical Manager

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Sample Name:Bore Water

Report Number:2005534 **Report Date:13/08/2016**

Customer Ref:RITES/UE/Chennai Metro/2016/02, Dt. 02/08/2016

S. No.	Test Parameters	Results	M.D.L.	Requirement as per IS:10500-2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
A.37.	Oil & Grease, mg/l	<1.0	-	-, -	IS:3025(P-39)1991	-
A.38.	Dissolved oxygen, mg/l	5.1	-	-, -	IS:3025(P-38)1989	-
A.39.	Chemical oxygen demand, mg/l	36.0	-	-, -	IS:3025(P-58)2006	-
A.40.	Biochemical oxygen demand, mg/l	11.0	-		IS:3025(P-44)1993	-
A.41.	Total phosphate, mg/l	0.3	0.1	-, -	IS:3025(P-31)1988	-
A.42.	Dissolved phosphate (as P), mg/l	0.3	0.1	-, -	IS:3025(P-31)1988	-
A.43.	Sodium (as Na), mg/l	352.5	2.0	-, -	IS:3025(P-45)1993	-
A.44.	Potassium (as K), mg/l	3.4	2.0	-, -	IS:3025(P-45)1993	-
A.45.	Nitrate nitrogen, mg/l	2.1	0.2	-, -	IS:3025(P-34)1988	-
A.46.	Total nitrogen, mg/l	11.8	-	-, -	IS:3025(P-34)1988	-
A.47.	Organic phosphorus, mg/l	BDL	0.00001	-, -	USEPA 8141 A	-
B.	**Microbiological Examination**					
B.1.	**Coliform count, MPN/100ml**	**35**	**-**	**Shall not be detectable in any 100ml. sample**	**IS:1622-1981**	**No**
B.2.	Faecal coliform, MPN/100ml	<1	-	-, -	IS:1622-1981	-
B.3.	Total coliform organism, cfu/100ml	12	-	-, -	IS:1622-1981	-

Remarks :Protocol-: IS: 10500-2012 for Acceptable limit/Permissible limit.
Note:- According to IS:10500-2012 ,it is recommended that the acceptable limit is to be implemented. Values greater than the acceptable limits render the water is not suitable, but still may be tolerated in the absence of an alternate source but upto permissible limits.
BDL = Below detection limit, MDL = Method detection limit.

***** End of Report *****

Authorised Signatory:
SANTRAM RAJPUT
Technical Manager

WWW.SIGMATEST.O

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TEST REPORT

Accredited by NABL & NABET, Certified ISO 9001:2015 & ISO 14001:2015

Report No	: PCEI/TR-W-4420	**Report Date**	: 16.12.2019
ULR No.	: ULR-TC244619000343JP		
Issued to	: **M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyembedu, Chennai - 600 107		
Sampling Method	: -		
Sampled by	: Customer		
Sample Collected Date	: 11.12.2019	**Sample Reference No**	: PCEI/W-N033-12-19
Sample Description	: **Water**	**Sample Received On**	: 12.12.2019
Qty of Sample Received	: 2.5 Litre	**Test Commenced On**	: 12.12.2019
Sample Condition	: Fit for Analysis	**Test Completed On**	: 16.12.2019
Sampling Location	: **Borewell Water - Near Adambakkam MRTS**		

S.No	Parameters	Units	Test Method	Results
1	pH @ 25°C	-	IS 3025 (Part 11) 1983 (RA 2017)	6.97
2	Turbidity	NTU	IS 3025 (Part 10) 1984 (RA 2017)	BDL(DL:0.1)
3	Total Dissolved Solids (TDS) @ 180°C	mg/L	IS 3025 (Part 16) 1984 (RA 2014)	921
4	Dissolved Oxygen	mg/L	IS 3025 (Part 38) 1989 (RA 2019)	7.1
5	Aluminium (as Al)	mg/L	IS 3025 (Part 55) 2003 (RA 2014)	BDL(DL:0.01)
6	Ammonia (as total Ammonia - N)	mg/L	IS 3025 (Part 34) 1988 (RA 2003)	BDL(DL:1.0)
7	Total Suspended Solids @ 105°C	mg/L	IS 3025 (Part 17) 1984 (RA 2017)	4.6
8	Barium (as Ba)	mg/L	IS 13428:2014 (Annex K)	BDL(DL:0.01)
9	Boron (as B)	mg/L	IS 3025 (Part 57) 2005 (RA 2017)	0.08
10	Calcium (as Ca)	mg/L	IS 3025 (Part 40) 1991 (RA 2014)	109
11	Chloride (as Cl)	mg/L	IS 3025 (Part 32) 1988 (RA 2014)	147
12	Copper (as Cu)	mg/L	IS 3025 (Part 42) 1992 (RA 2014)	BDL(DL:0.01)
13	Fluoride (as F)	mg/L	APHA 23rd Edition 4500 F-D	0.46
14	Iron (as Fe)	mg/L	IS 3025 (Part 53) 2003 (RA 2014)	0.38
15	Magnesium (Mg)	mg/L	IS 3025 (Part 46) 1994 (RA 2014)	32
16	Manganese (as Mn)	mg/L	IS 3025 (Part 59) 2006 (RA 2017)	BDL(DL:0.01)
17	Nitrate Nitrogen	mg/L	IS 3025 (Part 34) 1988 (RA 2014)	32
18	Total Nitrogen	mg/L	IS 3025 (Part 34) 1988 (RA 2014)	47
19	Oil & Grease	mg/L	IS 3025 (Part 39) 1991 (RA 2014)	BDL(DL:5.0)
20	Hexavalent Chromium (as Cr^{+6})	mg/L	IS 3025 (Part 52) 2003 (RA 2014)	BDL(DL:0.01)
21	Biochemical Oxygen Demand (BOD)(3 days at 27°C)	mg/L	IS 3025 (Part 44) 1993 (RA 2014)	BDL(DL:2.0)
22	Chemical Oxygen Demand (COD)	mg/L	IS 3025 (Part 58) 2006 (RA 2017)	BDL(DL:4.0)
23	Organic Phosphorous	mg/L	APHA 23rd Edition 4500 P	0.21

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Report No	: PCEI/TR-W-4420	Report Date	: 16.12.2019

S.No	Parameters	Units	Test Method	Results
24	Vanadium (as	mg/L	IS 3025 (Part 2)	0.21
25	Nitrate (as NO_3)	mg/L	IS 3025 (Part 34) 1988 (RA 2014)	0.14
26	Phenolic Compounds (C_6H_5OH)	mg/L	IS 3025 (Part 43) 1992(RA 2009)	BDL(DL:0.001)
27	Selenium (as Se)	mg/L	IS 3025 (Part 56) 2003 (RA 2014)	BDL(DL:0.002)
28	Silver (as Ag)	mg/L	IS 13428:2005 (Annex J)	BDL(DL:0.001)
29	Sulphates (as SO_4)	mg/L	IS 3025 (Part 24) 1986 (RA 2014)	2.7
30	Sulphide (as H_2S)	mg/L	IS 3025 (Part 29) 1986 (RA 2003)	BDL(DL:1.0)
31	Ammonical Nitrogen (as N)	mg/L	IS 3025 (Part 34) 1988 (RA 2014)	BDL(DL:1.0)
32	Total Kjehdahl Nitrogen (as N)	mg/L	IS 3025 (Part 34) 1988 (RA 2014)	BDL(DL:1.0)
33	Zinc (as Zn)	mg/L	IS 3025 (Part 49) 1994 (RA 2014)	3.9
34	Cadmium (as Cd)	mg/L	IS 3025 (Part 41) 1992 (RA 2014)	BDL(DL:0.01)
35	Cyanide (as CN)	mg/L	IS 3025 (Part 27) 1986 (RA 2014)	BDL(DL:0.01)
36	Lead (as Pb)	mg/L	IS 3025 (Part 47) 1994 (RA 2014)	BDL(DL:0.01)
37	Mercury (as Hg)	mg/L	IS 3025 (Part 48) 1994 (RA 2014)	BDL(DL:0.0001)
38	Nickel (as Ni)	mg/L	IS 3025 (Part 54) (RA 2003)	BDL(DL:0.01)
39	Total Phosphate	mg/L	IS 3025 (Part 31) 1988 (RA 2019)	0.62
40	Dissolved Phosphate (as PO_4)	mg/L	IS 3025 (Part 31) 1988 (RA 2019)	0.38
41	Arsenic (as As)	mg/L	IS 3025 (Part 37) 1988 (RA 2014)	BDL (DL:0.5)
42	Chromium (as Cr)	mg/L	IS 3025 (Part 52) 2003 (RA 2014)	BDL (DL:0.5)
43	Total Hardness (as $CaCO_3$)	mg/L	IS 3025 (Part 21) 2009 (RA 2014)	402
44	Sodium (as Na)	mg/L	IS 3025 (Part 45) 1993 (RA 2014)	86
45	Potassium (as K)	mg/L	IS 3025 (Part 45) 1993 (RA 2014)	11.6
46	Total Alkalinity (as $CaCO_3$)	mg/L	IS 3025 (Part 23) 1986 (RA 2014)	268
Micro-Biological Parameters				
47	Escherichia coli (MPN)	MPN/100ml	IS 1622:1981 (RA 2009)	8
48	Total coliform (MPN)	MPN/100ml	IS 1622:1981 (RA 2009)	23
49	Fecal Coliform	MPN/100ml	IS 1622:1981 (RA 2009)	11

Note: BDL - Below Detection Limit; DL - Detection Limit
All the above test parameters are carried with the sample's "as received condition"

..... End of Report .....

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TEST REPORT

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Report No	: PCEI/TR-III-4421	**Report Date**	: 16.12.2019
ULR No.	: ULR-TC744619000J434P		
Issued to	: **M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: -		
Sampled by	: Customer		
Sample Collected Date	: 11.12.2019	**Sample Reference No**	: PCEI/W-N034-12-19
Sample Description	: **Water**	**Sample Received On**	: 12.12.2019
Qty of Sample Received	: 2.5 Litre	**Test Commenced On**	: 12.12.2019
Sample Condition	: Fit for Analysis	**Test Completed On**	: 16.12.2019
Sampling Location	: **Borewell Water - Madipakkam Koot Road Junction**		

S.No	Parameters	Units	Test Method	Results
1	pH @ 25°C	-	IS 3025 (Part 11) 1983 (RA 2017)	7.21
2	Turbidity	NTU	IS 3025 (Part 10) 1984 (RA 2017)	BDL(DL:0.1)
3	Total Dissolved Solids (TDS) @ 180°C	mg/L	IS 3025 (Part 16) 1984 (RA 2014)	225
4	Dissolved Oxygen	mg/L	IS 3025 (Part 38) 1989 (RA 2019)	7.1
5	Aluminium (as Al)	mg/L	IS 3025 (Part 55) 2003 (RA 2014)	BDL(DL:0.01)
6	Ammonia (as total Ammonia - N)	mg/L	IS 3025 (Part 34) 1988 (RA 2003)	BDL(DL: 1.0)
7	Total Suspended Solids @ 105°C	mg/L	IS 3025 (Part 17) 1984 (RA 2017)	BDL(DL:2.0)
8	Barium (as Ba)	mg/L	IS 13428:2014 (Annex K)	BDL(DL:0.01)
9	Boron (as B)	mg/L	IS 3025 (Part 57) 2005 (RA 2017)	BDL(DL:0.01)
10	Calcium (as Ca)	mg/L	IS 3025 (Part 40) 1991 (RA 2014)	24.2
11	Chloride (as Cl)	mg/L	IS 3025 (Part 32) 1988 (RA 2014)	43.5
12	Copper (as Cu)	mg/L	IS 3025 (Part 42) 1992 (RA 2014)	BDL(DL:0.01)
13	Fluoride (as F)	mg/L	APHA 23rd Edition 4500 F-D	0.68
14	Iron (as Fe)	mg/L	IS 3025 (Part 53) 2003 (RA 2014)	0.11
15	Magnesium (Mg)	mg/L	IS 3025 (Part 46) 1994 (RA 2014)	10.3
16	Manganese (as Mn)	mg/L	IS 3025 (Part 59) 2006 (RA 2017)	0.03
17	Nitrate Nitrogen	mg/L	IS 3025 (Part 34) 1988 (RA 2014)	BDL(DL:1.0)
18	Total Nitrogen	mg/L	IS 3025 (Part 34) 1988 (RA 2014)	BDL(DL:1.0)
19	Oil & Grease	mg/L	IS 3025 (Part 39) 1991 (RA 2014)	BDL(DL:5.0)
20	Hexavalent Chromium (as Cr^{+6})	mg/L	IS 3025 (Part 52) 2003 (RA 2014)	BDL(DL:0.01)
21	Biochemical Oxygen Demand [BOD](3 days at 27°C)	mg/L	IS 3025 (Part 44) 1993 (RA 2014)	BDL(DL:2.0)
22	Chemical Oxygen Demand (COD)	mg/L	IS 3025 (Part 58) 2006 (RA 2017)	BDL(DL:4.0)
23	Organic Phosphorous	mg/L	APHA 23rd Edition 4500 P	0.05

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Report No	: PCEI/TR-W-4421	Report Date	: 16.12.2019

S.No	Parameters	Units	Test Method	Results
24	Vanadium (as	mg/L	IS 3025 (Part 2)	BDL(DL:0.01)
25	Nitrate (as NO_3)	mg/L	IS 3025 (Part 34) 1988 (RA 2014)	18
26	Phenolic Compounds (C_6H_5OH)	mg/L	IS 3025 (Part 43) 1992(RA 2008)	BDL(DL:0.001)
27	Selenium (as Se)	mg/L	IS 3025 (Part 56) 2003 (RA 2014)	BDL(DL:0.002)
28	Silver (as Ag)	mg/L	IS 13428 2005 (Annex J)	BDL(DL:0.001)
29	Sulphates (as SO_4)	mg/L	IS 3025 (Part 24) 1986 (RA 2014)	42.3
30	Sulphide (as H_2S)	mg/L	IS 3025 (Part 29) 1986 (RA 2003)	BDL(DL:1.0)
31	Ammonical Nitrogen (as N)	mg/L	IS 3025 (Part 34) 1988 (RA 2014)	BDL(DL:1.0)
32	Total Kjehdahl Nitrogen (as N)	mg/L	IS 3025 (Part 34) 1988 (RA 2014)	BDL(DL:1.0)
33	Zinc (as Zn)	mg/L	IS 3025 (Part 49) 1994 (RA 2014)	2.1
34	Cadmium (as Cd)	mg/L	IS 3025 (Part 41) 1992 (RA 2014)	BDL(DL:0.01)
35	Cyanide (as CN)	mg/L	IS 3025 (Part 27) 1986 (RA 2014)	BDL(DL:0.01)
36	Lead (as Pb)	mg/L	IS 3025 (Part 47) 1994 (RA 2014)	BDL(DL:0.01)
37	Mercury (as Hg)	mg/L	IS 3025 (Part 48) 1994 (RA 2014)	BDL(DL:0.0001)
38	Nickel (as Ni)	mg/L	IS 3025 (Part 54) (RA 2003)	BDL(DL:0.01)
39	Total Phosphate	mg/L	IS 3025 (Part 31) 1988 (RA 2019)	0.42
40	Dissolved Phosphate (as PO_4)	mg/L	IS 3025 (Part 31) 1988 (RA 2019)	0.11
41	Arsenic (as As)	mg/L	IS 3025 (Part 37) 1988 (RA 2014)	BDL (DL:0.5)
42	Chromium (as Cr)	mg/L	IS 3025 (Part 52) 2003 (RA 2014)	BDL (DL:0.5)
43	Total Hardness (as $CaCO_3$)	mg/L	IS 3025 (Part 21) 2009 (RA 2014)	103
44	Sodium (as Na)	mg/L	IS 3025 (Part 45) 1993 (RA 2014)	46
45	Potassium (as K)	mg/L	IS 3025 (Part 45) 1993 (RA 2014)	13.2
46	Total Alkalinity (as $CaCO_3$)	mg/L	IS 3025 (Part 23) 1986 (RA 2014)	92
Micro-Biological Parameters				
47	Escherichia coli (MPN)	MPN/100ml	IS 1622:1981 (RA 2009)	2
48	Total coliform (MPN)	MPN/100ml	IS 1622:1981 (RA 2009)	17
49	Fecal Coliform	MPN/100ml	IS 1622:1981 (RA 2009)	4

Note: BDL - Below Detection Limit; DL - Detection Limit
All the above test parameters are carried with the sample's "as received condition"

..... End of Report .....

Verified by

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Designation: Technical Manager

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Report No	: PCEI/TR-W-4422	**Report Date**	: 16.12.2019
ULR No.	: ULR-TC744619000I3415P		
Issued to	: **M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: -		
Sampled by	: Customer		
Sample Collected Date	: 11.12.2019	**Sample Reference No**	: PCEI/W-N035-12-19
Sample Description	: **Water**	**Sample Received On**	: 12.12.2019
Qty of Sample Received	: 2.5 Litre	**Test Commenced On**	: 12.12.2019
Sample Condition	: Fit for Analysis	**Test Completed On**	: 16.12.2019
Sampling Location	: **Borewell Water - Velikkai Bus Stop**		

S.No	Parameters	Units	Test Method	Results
1	pH @ 25°C	-	IS 3025 (Part 11) 1983 (RA 2017)	7.61
2	Turbidity	NTU	IS 3025 (Part 10) 1984 (RA 2017)	BDL(DL:0.1)
3	Total Dissolved Solids (TDS) @ 180°C	mg/L	IS 3025 (Part 16) 1984 (RA 2014)	179
4	Dissolved Oxygen	mg/L	IS 3025 (Part 38) 1989 (RA 2019)	7.6
5	Aluminium (as Al)	mg/L	IS 3025 (Part 55) 2003 (RA 2014)	BDL(DL:0.01)
6	Ammonia (as total Ammonia - N)	mg/L	IS 3025 (Part 34) 1988 (RA 2003)	BDL(DL:1.0)
7	Total Suspended Solids @ 105°C	mg/L	IS 3025 (Part 17) 1984 (RA 2017)	BDL(DL:2.0)
8	Barium (as Ba)	mg/L	IS 13428:2014 (Annex K)	BDL(DL:0.01)
9	Boron (as B)	mg/L	IS 3025 (Part 57) 2005 (RA 2017)	BDL(DL:0.01)
10	Calcium (as Ca)	mg/L	IS 3025 (Part 40) 1991 (RA 2014)	44.4
11	Chloride (as Cl)	mg/L	IS 3025 (Part 32) 1988 (RA 2014)	14.5
12	Copper (as Cu)	mg/L	IS 3025 (Part 42) 1992 (RA 2014)	BDL(DL:0.01)
13	Fluoride (as F)	mg/L	APHA 23rd Edition 4500 F-D	0.72
14	Iron (as Fe)	mg/L	IS 3025 (Part 53) 2003 (RA 2014)	0.13
15	Magnesium (Mg)	mg/L	IS 3025 (Part 46) 1994 (RA 2014)	11.3
16	Manganese (as Mn)	mg/L	IS 3025 (Part 59) 2006 (RA 2017)	BDL(DL:0.01)
17	Nitrate Nitrogen	mg/L	IS 3025 (Part 34) 1988 (RA 2014)	BDL(DL:1.0)
18	Total Nitrogen	mg/L	IS 3025 (Part 34) 1988 (RA 2014)	BDL(DL:1.0)
19	Oil & Grease	mg/L	IS 3025 (Part 39) 1991 (RA 2014)	BDL(DL:5.0)
20	Hexavalent Chromium (as Cr^{+6})	mg/L	IS 3025 (Part 52) 2003 (RA 2014)	BDL(DL:0.01)
21	Biochemical Oxygen Demand (BOD)(3 days at 27°C)	mg/L	IS 3025 (Part 44) 1993 (RA 2014)	BDL(DL:2.0)
22	Chemical Oxygen Demand (COD)	mg/L	IS 3025 (Part 58) 2006 (RA 2017)	BDL(DL:4.0)
23	Organic Phosphorous	mg/L	APHA 23rd Edition 4500 P	0.06

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Report No	: POEI/TR-W-4422	Report Date	: 16.12.2019

S.No	Parameters	Units	Test Method	Results
24	Vanadium (as	mg/L	IS 3025 (Part 2)	BDL(DL:0.01)
25	Nitrate (as NO_3)	mg/L	IS 3025 (Part 34) 1988 (RA 2014)	19
26	Phenolic Compounds (C_6H_5OH)	mg/L	IS 3025 (Part 43) 1992(RA 2009)	BDL(DL:0.001)
27	Selenium (as Se)	mg/L	IS 3025 (Part 56) 2003 (RA 2014)	BDL(DL:0.002)
28	Silver (as Ag)	mg/L	IS 13428:2005 (Annex J)	BDL(DL:0.001)
29	Sulphates (as SO_4)	mg/L	IS 3025 (Part 24) 1986 (RA 2014)	10.1
30	Sulphide (as H_2S)	mg/L	IS 3025 (Part 29) 1986 (RA 2003)	BDL(DL:1.0)
31	Ammonical Nitrogen (as N)	mg/L	IS 3025 (Part 34) 1988 (RA 2014)	BDL(DL:1.0)
32	Total Kjehdahl Nitrogen (as N)	mg/L	IS 3025 (Part 34) 1988 (RA 2014)	BDL(DL:1.0)
33	Zinc (as Zn)	mg/L	IS 3025 (Part 49) 1994 (RA 2014)	1.9
34	Cadmium (as Cd)	mg/L	IS 3025 (Part 41) 1992 (RA 2014)	BDL(DL:0.01)
35	Cyanide (as CN)	mg/L	IS 3025 (Part 27) 1986 (RA 2014)	BDL(DL:0.01)
36	Lead (as Pb)	mg/L	IS 3025 (Part 47) 1994 (RA 2014)	BDL(DL:0.01)
37	Mercury (as Hg)	mg/L	IS 3025 (Part 48) 1994 (RA 2014)	BDL(DL:0.0001)
38	Nickel (as Ni)	mg/L	IS 3025 (Part 54) (RA 2003)	BDL(DL:0.01)
39	Total Phosphate	mg/L	IS 3025 (Part 31) 1988 (RA 2019)	0.36
40	Dissolved Phosphate (as PO_4)	mg/L	IS 3025 (Part 31) 1988 (RA 2019)	0.14
41	Arsenic (as As)	mg/L	IS 3025 (Part 37) 1988 (RA 2014)	BDL (DL:0.5)
42	Chromium (as Cr)	mg/L	IS 3025 (Part 52) 2003 (RA 2014)	BDL (DL:0.5)
43	Total Hardness (as $CaCO_3$)	mg/L	IS 3025 (Part 21) 2009 (RA 2014)	157
44	Sodium (as Na)	mg/L	IS 3025 (Part 45) 1993 (RA 2014)	38
45	Potassium (as K)	mg/L	IS 3025 (Part 45) 1993 (RA 2014)	8.6
46	Total Alkalinity (as $CaCO_3$)	mg/L	IS 3025 (Part 23) 1986 (RA 2014)	72
Micro-Biological Parameters				
47	Escherichia coli (MPN)	MPN/100ml	IS 1622:1981 (RA 2009)	2
48	Total coliform (MPN)	MPN/100ml	IS 1622:1981 (RA 2009)	22
49	Fecal Coliform	MPN/100ml	IS 1622:1981 (RA 2009)	8

Note: BDL - Below Detection Limit; DL - Detection Limit
All the above test parameters are carried with the sample's "as received condition"

..... End of Report .....

Verified by

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Please share your feedback

USFDA DUNS No.864393171

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TESTING OF FOOD | WATER | CHEMICALS | PETROLEUM PRODUCTS | BUILDING MATERIAL | ENVIRONMENT

TEST CERTIFICATE

(This certificate is not valid without a hologram)

Sample Name:Bore Water

Report Number:2005537 **Report Date:13/08/2016**

Customer Ref:RITES/UE/Chennai Metro/2016/02, Dt. 02/08/2016

Customer Name & Address : Rites Limited Rites Bhawan, No.1, Sector-29, Gurgaon, Haryana - 122001	Job No. STRC/2005537 Received On 03/08/2016 Sample Quantity 10 litre Packing : Filled in pet bottle Sample Location: Medavakkam Juction Sub: Analysis of Water Samples for Chennai Metro Rail Project Phase-II.

S. No.	Test Parameters	Results	M.D.L.	Requirement as per IS:10500-2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
A.	**Chemical Parameters**					
A.1.	pH value at 25°C	7.99	-	6.5-8.5/No relaxation	IS:3025(P-11)1983	YES
A.2.	Turbidity, NTU	<0.1	-	1.0/5.0 Max.	IS:3025(P-10)1984	YES
A.3.	**Total Dissolved Solids, mg/l**	**1,256.0**	-	**500/2000 Max.**	**IS:3025(P-16)1984**	**NO**
A.4.	Aluminium (as Al), mg/l	BDL	0.01	0.03/0.2 Max.	APHA 22nd Edn. 2012:3125B	YES
A.5.	Free ammonia (as NH3), mg/l	<0.1	-	-,-	IS:3025(P-34)1988	-
A.6.	Barium (as Ba), mg/l	0.046	0.002	0.7 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.7.	Boron (as B), mg/l	0.04	0.02	0.5/1.0 Max.	APHA 22nd Edn. 2012:3125B	YES
A.8.	**Calcium (as Ca), mg/l**	**206.4**	-	**75/200 Max.**	**IS:3025(P-40)1991**	**NO**
A.9.	**Chloride (as Cl), mg/l**	**280.9**	-	**250/1000 Max.**	**IS:3025(P-32)1988**	**NO**
A.10.	Copper (as Cu), mg/l	BDL	0.002	0.05/1.5 Max.	APHA 22nd Edn. 2012:3125B	YES
A.11.	**Fluoride (as F), mg/l**	**>1.0**	-	**1.0/1.5 Max.**	**IS:3025(P-60)2008**	**NO**
A.12.	Free Residual Chlorine, mg/l	N.A	-	0.2Min./1.0 Max.	IS:3025(P-26)1986	-
A.13.	Iron (as Fe), mg/l	BDL	0.1	1.0 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.14.	Magnesium (as Mg), mg/l	27.6	-	30/100 Max.	IS:3025(P-46)1994	YES
A.15.	Manganese (as Mn), mg/l	BDL	0.002	0.1/0.3 Max.	APHA 22nd Edn. 2012:3125B	YES
A.16.	Nitrate (as NO3), mg/l	17.2	1.0	45 Max./No relaxation	IS:3025(P-34)1988	YES
A.17.	Phenolic Compound (as C6H5OH), mg/l	BDL	0.001	0.001/0.002 Max.	IS:3025(P-43)1992	YES

Authorised Signatory:
SANTRAM RAJPUT
Technical Manager

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Sample Name:Bore Water — Report Date:13/08/2016

Report Number:2005537

Customer Ref:RITES/UE/Chennai Metro/2016/02, Dt. 02/08/2016

S. No.	Test Parameters	Results	M.D.L.	Requirement as per IS:10500-2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
A.18.	Selenium (as Se), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.19.	Silver (as Ag), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.20.	Sulphate (as SO4), mg/l	11.7	5.0	200/400 Max.	IS:3025(P-24)1986	YES
A.21.	Sulphide (as S), mg/l	BDL	0.05	0.05 max./No relaxation	IS:3025(P-29)1986	YES
A.22.	**Total alkalinity (as CaCO3), mg/l**	**382.2**	-	**200/600 Max.**	**IS:3025(P-23)1986**	**NO**
A.23.	**Total Hardness (as CaCo3), mg/l**	**628.3**	-	**200/600 Max.**	**IS:3025(P-21)2009**	**NO**
A.24.	Zinc (as Zn), mg/l	BDL	0.02	5.0/15.0 Max.	APHA 22nd Edn. 2012:3125B	YES
A.25.	Cadmium (as Cd), mg/l	BDL	0.002	0.003 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.26.	Cyanide (as CN), mg/l	BDL	0.02	0.05 Max./No relaxation	IS:3025(P-27)1986	YES
A.27.	Lead (as Pb), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2g12:3125B	YES
A.28.	Mercury (as Hg), mg/l	0.0008	0.0002	0.001 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.29.	Nickel (as Ni), mg/l	0.002	0.002	0.02 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.30.	Total Arsenic (as As), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.31.	Total Chromium (as Cr), mg/l	BDL	0.002	0.05 max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.32.	Total suspended solids, mg/l	3.0	-	-,-	IS:3025(P-17)1984	-
A.33.	Vanadium (as V), mg/l	BDL	0.002	-,-	APHA 22nd Edn. 2012:3125B	-
A.34.	Ammonical Nitrogen (as N)	<0.1	-	0.5 max./No relaxation	IS:3025(P-34)1988	YES
A.35.	Total kjeldahl nitrogen (as N)	21.5	-	-,-	IS:3025(P-34)1988	-
A.36.	Chromium (as hexavalent chromium), mg/l	BDL	0.1	-,-	IS:3025(P-52)2003	-

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Sample Name:Bore Water

Report Number:2005537 **Report Date:13/08/2016**

Customer Ref:RITES/UE/Chennai Metro/2016/02, Dt. 02/08/2016

S. No.	Test Parameters	Results	M.D.L.	Requirement as per IS:10500-2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
A.37.	Oil & Grease, mg/l	<1.0	-	-, -	IS:3025(P-39)1991	-
A.38.	Dissolved oxygen, mg/l	4.5	-	-, -	IS:3025(P-38)1989	-
A.39.	Chemical oxygen demand, mg/l	60.0	-	-, -	IS:3025(P-58)2006	-
A.40.	Biochemical oxygen demand, mg/l	23.0	-		IS:3025(P-44)1993	-
A.41.	Total phosphate, mg/l	1.1	0.1	-, -	IS:3025(P-31)1988	-
A.42.	Dissolved phosphate (as P), mg/l	1.1	0.1	-, -	IS:3025(P-31)1988	-
A.43.	Sodium (as Na), mg/l	150.0	2.0	-, -	IS:3025(P-45)1993	-
A.44.	Potassium (as K), mg/l	6.0	2.0	-, -	IS:3025(P-45)1993	-
A.45.	Nitrate nitrogen, mg/l	3.9	0.2	-, -	IS:3025(P-34)1988	-
A.46.	Total nitrogen, mg/l	21.5	-	-, -	IS:3025(P-34)1988	-
A.47.	Organic phosphorus, mg/l	BDL	0.00001	-, -	USEPA 8141 A	-
B.	**Microbiological Examination**					
B.1.	Coliform count, MPN/100ml	<1	-	Shall not be detectable in any 100ml. sample	IS:1622-1981	Yes
B.2.	Faecal coliform, MPN/100ml	<1	-	-, -	IS:1622-1981	-
B.3.	Total coliform organism, cfu/100ml	<1	-	-, -	IS:1622-1981	-

Remarks : Protocol-: IS: 10500-2012 for Acceptable limit/Permissible limit.
Note:- According to IS:10500-2012 ,it is recommended that the acceptable limit is to be implemented. Values greater than the acceptable limits render the water is not suitable, but still may be tolerated in the absence of an alternate source but upto permissible limits.
BDL = Below detection limit, MDL = Method detection limit.

***** End of Report *****

Authorised Signatory:
SANTRAM RAJPUT
Technical Manager

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Sample Name:Surface Water

Report Number:2005538 **Report Date:13/08/2016**

Customer Ref:RITES/UE/Chennai Metro/2016/02, Dt. 02/08/2016

Customer Name & Address	Job No.	STRC/2005538
Rites Limited Rites Bhawan, No.1, Sector-29, Gurgaon, Haryana - 122001	Received On	03/08/2016
	Sample Quantity	10 litre
	Packing : Filled in pet bottle Sample Location: Near Global Hospital Sub: Analysis of Water Samples for Chennai Metro Rail Project Phase-II.	

S. No.	Test Parameters	Results	M.D.L.	Requirement as per IS:10500-2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
A.	**Chemical Parameters**					
A.1.	pH value at 25°C	8.15	-	6.5-8.5/No relaxation	IS:3025(P-11)1983	YES
A.2.	**Turbidity, NTU**	**76.5**	**-**	**1.0/5.0 Max.**	**IS:3025(P-10)1984**	**NO**
A.3.	**Total Dissolved Solids, mg/l**	**4,386.0**	**-**	**500/2000 Max.**	**IS:3025(P-16)1984**	**NO**
A.4.	**Aluminium (as Al), mg/l**	**0.054**	**0.01**	**0.03/0.2 Max.**	**APHA 22nd Edn. 2012:3125B**	**NO**
A.5.	Free ammonia (as NH3), mg/l	>0.5	-	-, -	IS:3025(P-34)1988	-
A.6.	Barium (as Ba), mg/l	0.23	0.002	0.7 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.7.	Boron (as B), mg/l	BDL	0.02	0.5/1.0 Max.	APHA 22nd Edn. 2012:3125B	YES
A.8.	**Calcium (as Ca), mg/l**	**123.8**	**-**	**75/200 Max.**	**IS:3025(P-40)1991**	**NO**
A.9.	**Chloride (as Cl), mg/l**	**1,995.7**	**-**	**250/1000 Max.**	**IS:3025(P-32)1988**	**NO**
A.10.	Copper (as Cu), mg/l	BDL	0.002	0.05/1.5 Max.	APHA 22nd Edn. 2012:3125B	YES
A.11.	**Fluoride (as F), mg/l**	**>1.0**	**-**	**1.0/1.5 Max.**	**IS:3025(P-60)2008**	**NO**
A.12.	Free Residual Chlorine, mg/l	N.A	-	0.2Min./1.0 Max.	IS:3025(P-26)1986	-
A.13.	Iron (as Fe), mg/l	0.14	0.1	1.0 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.14.	**Magnesium (as Mg), mg/l**	**188.1**	**-**	**30/100 Max.**	**IS:3025(P-46)1994**	**NO**
A.15.	**Manganese (as Mn), mg/l**	**0.21**	**0.002**	**0.1/0.3 Max.**	**APHA 22nd Edn. 2012:3125B**	**NO**
A.16.	Nitrate (as NO3), mg/l	1.1	1.0	45 Max./No relaxation	IS:3025(P-34)1988	YES
A.17.	Phenolic Compound (as C6H5OH), mg/l	BDL	0.001	0.001/0.002 Max.	IS:3025(P-43)1992	YES

Authorised Signatory:
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Sample Name:Surface Water

Report Number:2005538 **Report Date:13/08/2016**

Customer Ref:RITES/UE/Chennai Metro/2016/02, Dt. 02/08/2016

S. No.	Test Parameters	Results	M.D.L.	Requirement as per IS:10500-2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
A.18.	Selenium (as Se), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.19.	Silver (as Ag), mg/l	BDL	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.20.	Sulphate (as SO4), mg/l	155.6	5.0	200/400 Max.	IS:3025(P-24)1986	YES
A.21.	Sulphide (as S), mg/l	BDL	0.05	0.05 max./No relaxation	IS:3025(P-29)1986	YES
A.22.	**Total alkalinity (as CaCO3), mg/l**	**225.4**	**-**	**200/600 Max.**	**IS:3025(P-23)1986**	**NO**
A.23.	**Total Hardness (as CaCo3), mg/l**	**1,081.5**	**-**	**200/600 Max.**	**IS:3025(P-21)2009**	**NO**
A.24.	Zinc (as Zn), mg/l	BDL	0.02	5.0/15.0 Max.	APHA 22nd Edn. 2012:3125B	YES
A.25.	Cadmium (as Cd), mg/l	BDL	0.002	0.003 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.26.	Cyanide (as CN), mg/l	BDL	0.02	0.05 Max./No relaxation	IS:3025(P-27)1986	YES
A.27.	Lead (as Pb), mg/l	0.009	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.28.	Mercury (as Hg), mg/l	BDL	0.0002	0.001 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.29.	Nickel (as Ni), mg/l	0.004	0.002	0.02 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.30.	Total Arsenic (as As), mg/l	0.003	0.002	0.01 Max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.31.	Total Chromium (as Cr), mg/l	BDL	0.002	0.05 max./No relaxation	APHA 22nd Edn. 2012:3125B	YES
A.32.	Total suspended solids, mg/l	184.0	-	-, -	IS:3025(P-17)1984	-
A.33.	Vanadium (as V), mg/l	BDL	0.002	-, -	APHA 22nd Edn. 2012:3125B	-
A.34.	**Ammonical Nitrogen (as N)**	**>0.5**	**-**	**0.5 max./No relaxation**	**IS:3025(P-34)1988**	**NO**
A.35.	Total kjeldahl nitrogen (as N)	3.2	-	-, -	IS:3025(P-34)1988	-
A.36.	Chromium (as hexavalent chromium), mg/l	BDL	0.1	-, -	IS:3025(P-52)2003	-

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Sample Name:Surface Water
Report Number:2005538 **Report Date:13/08/2016**
Customer Ref:RITES/UE/Chennai Metro/2016/02, Dt. 02/08/2016

S. No.	Test Parameters	Results	M.D.L.	Requirement as per IS:10500-2012 Acceptable Limit/Permissible Limit	Test Method	Conformity
A.37.	Oil & Grease, mg/l	1.0	-	-, -	IS:3025(P-39)1991	-
A.38.	Dissolved oxygen, mg/l	3.7	-	-, -	IS:3025(P-38)1989	-
A.39.	Chemical oxygen demand, mg/l	220.0	-	-, -	IS:3025(P-58)2006	-
A.40.	Biochamical oxygen demand, mg/l	75.0	-		IS:3025(P-44)1993	-
A.41.	Total phosphate, mg/l	0.27	0.1	-, -	IS:3025(P-31)1988	-
A.42.	Dissolved phosphate (as P), mg/l	0.27	0.1	-, -	IS:3025(P-31)1988	-
A.43.	Sodium (as Na), mg/l	1,010.0	2.0	-, -	IS:3025(P-45)1993	-
A.44.	Potassium (as K), mg/l	30.0	2.0	-, -	IS:3025(P-45)1993	-
A.45.	Nitrate nitrogen, mg/l	0.25	0.2	-, -	IS:3025(P-34)1988	-
A.46.	Total nitrogen, mg/l	3.2	-	-, -	IS:3025(P-34)1988	-
A.47.	Organic phosphorus, mg/l	BDL	0.00001	-, -	USEPA 8141 A	-
B.	**Microbiological Examination**					
B.1.	**Coliform count, MPN/100ml**	**54**	-	**Shall not be detectable in any 100ml. sample**	**IS:1622-1981**	**No**
B.2.	Faecal coliform, MPN/100ml	<1	-	-, -	IS:1622-1981	-
B.3.	Total coliform organism, cfu/100ml	14	-	-, -	IS:1622-1981	-

Remarks :Protocol-: IS: 10500-2012 for Acceptable limit/Permissible limit.
Note:- According to IS:10500-2012 ,it is recommended that the acceptable limit is to be implemented. Values greater than the acceptable limits render the water is not suitable, but stil may be tolerated in the absence of an alternate source but upto permissible limits.
BDL = Below detection limit, MDL = Method detection limit.

***** End of Report *****

Authorised Signatory:
SANTRAM RAJPUT
Technical Manager

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TEST REPORT

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Report No:	PCEI/TR-W-2672	**Report Date:**	09.10.2020
Issued to:	**M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method:	IS 3025 (Part 1) 1987 (RA 2014)		
Sampled by:	Laboratory		
Sample Collected Date:	06.10.2020	**Sample Condition:**	Fit for Analysis
Sample Description:	**Water**	**Sample Reference No:**	PCEI/WW-030-10-20
Qty of Sample Received:	2.5L	**Sample Received On:**	06.10.2020
Sample Mark:	SW-5	**Test Commenced On:**	06.10.2020
Sampling Location:	**Adampakkam Lake**	**Test Completed On:**	09.10.2020

S.No	Parameters	Units	Test Method	Results
1	Colour	-	IS 3025 (Part 4) 1983 (RA 2017)	Light Black
2	Odour	-	IS 3025 (Part 5) 1983 (RA 2017)	Disagreeable
3	Turbidity	NTU	IS 3025 (Part 10) 1984 (RA 2017)	106.8
4	pH Value @ 25 °C	-	IS 3025 (Part 11) 1983 (RA 2017)	6.93
5	Temperature	°C	IS 3025 (Part 9) 1984 (RA 2017)	30.6
6	Electrical Conductivity @ 25°C	µS/cm	IS 3025 (Part 14) 1984 (RA 2013)	1164
7	Total Dissolved Solids @ 180°C	mg/l	IS 3025 (Part 16) 1984 (RA 2017)	680
8	Total Suspended Solids @ 105°C	mg/l	IS 3025 (Part 17) 1984 (RA 2017)	313
9	Bio chemical Oxygen Demand (27°C for 3 days)	mg/l	IS 3025 (Part 44) 1993 (RA 2014)	42.1
10	Chemical Oxygen Demand (COD)	mg/l	IS 3025 (Part 58) 2006 (RA 2017)	160
11	Oil & Grease	mg/l	IS 3025 (Part 39) 1991 (RA 2014)	BDL(DL:5.0)
12	Aluminium (as Al)	mg/l	IS 3025 (Part 55) 2003 (RA 2014)	0.16
13	Boron (as B)	mg/l	IS 3025 (Part 57) 2005 (RA 2017)	0.08
14	Calcium (as Ca)	mg/l	IS 3025 (Part 40) 1991 (RA 2014)	89

Verified By

Authorised Signatory

Name: Krishnan G
Designation: Technical Manager

Note: 1.The test results are only to the sample submitted for test. 2.Any Correction of the test report in full or part shall invalidate the report 3.Sample will be retained for 15 days from the date of reporting except in case of regulatory samples or specifically instructed by client. 4.Perishable samples will be discarded immediately after reporting. 5.Under no circumstances lab accepts any liability or loss/damage caused by use or misuse of test report after invoicing or issued of test report

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TEST REPORT

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Report No:		PCEI/TR-W-2672	Report Date:	09.10.2020
S.No	Parameters	Units	Test Method	Results
15	Chlorides (as Cl)	mg/l	IS 3025 (Part 32) 1988 (RA 2003)	111
16	Copper (as Cu)	mg/l	IS 3025 (Part 42) 1992 (RA 2003)	0.19
17	Fluoride (as F)	mg/l	IS 3025 (Part 60) 2008 (RA 2013)	0.4
18	Free Residual Chlorine	mg/l	IS 3025 (Part 26) 1986 (RA 2003)	BDL(DL:0.1)
19	Iron (as Fe)	mg/l	IS 3025 (Part 53) 2003 (RA 2014)	0.76
20	Magnesium (as Mg)	mg/l	IS 3025 (Part 46) 1994 (RA 2003)	29.5
21	Potassium (as K)	mg/l	IS 3025 (Part 45) 1993 (RA 2014)	14.6
22	Silica (as SiO_2)	mg/l	IS 3025 (Part 35) 1988 RA 2014)	10.8
23	Manganese (as Mn)	mg/l	IS 3025 (Part 59) 2006 (RA 2017)	0.29
24	Nitrate (as NO_3)	mg/l	IS 3025 (Part 34) 1988 (RA 2003)	6.85
25	Phenolic Compound (as C_6H_5OH)	mg/l	IS 3025 (Part 43) 1992 (RA 2003)	BDL(DL:0.001)
26	Sulphates (as SO_4^{-2})	mg/l	IS 3025 (Part 24) 1986 (RA 2003)	85.3
27	Total Alkalinity (as $CaCO_3$)	mg/l	IS 3025 (Part 23) 1986 (RA 2003)	311
28	Total Hardness (as $CaCO_3$)	mg/l	IS 3025 (Part 21) 2009 (RA 2014)	343
29	Calcium Hardness	mg/l	IS 3025 (Part 40) 1991 (RA 2014)	222
30	Bicarbonates (as HCO_3)	mg/l	IS 3025 (Part 51) 2001 (RA 2017)	165
31	Zinc (as Zn)	mg/l	IS 3025 (Part 49) 1994 (RA 2003)	1.6
32	Cadmium (as Cd)	mg/l	IS 3025 (Part 41) 1992 (RA 2003)	BDL(DL:0.01)
33	Cyanide (as CN)	mg/l	IS 3025 (Part 27) 1986 (RA 2003)	BDL(DL:0.1)
34	Lead (as Pb)	mg/l	IS 3025 (Part 47) 1994 (RA 2003)	BDL(DL:0.01)
35	Nickel (as Ni)	mg/l	IS 3025 (Part 54) 2003 (RA 2014)	BDL(DL:0.01)
36	Total Arsenic (as As)	mg/l	IS 3025 (Part 37) 1988 (RA 1999)	BDL(DL:0.01)
37	Total Chromium (as Cr)	mg/l	IS 3025 (Part 52) 2003 (RA 2014)	BDL(DL:0.01)

Note: BDL - Below Detection Limit; DL - Detection Limit

..... End of Report .....
Page 2 of 2

Verified By

Authorised Signatory

Name: Krishnan G
Designation: Technical Manager

Note: 1.The test results are only to the sample submitted for test. 2.Any Correction of the test report in full or part shall invalidate the report 3.Sample will be retained for 15 days from the date of reporting except in case of regulatory samples or specifically instructed by client. 4.Perishable samples will be discarded immediately after reporting. 5.Under no circumstances lab accepts any liability or loss/damage caused by use or misuse of test report after invoicing or issued of test report

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TEST REPORT

Accredited by NABL & NABET, Certified ISO 9001:2015, ISO 14001:2015 & ISO 45001 : 2018

Report No:	PCEI/TR-W-2673	**Report Date:**	09.10.2020
Issued to:	**M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method:	IS 3025 (Part 1) 1987 (RA 2014)		
Sampled by:	Laboratory		
Sample Collected Date:	06.10.2020	**Sample Condition:**	Fit for Analysis
Sample Description:	**Water**	**Sample Reference No:**	PCEI/WW-030-10-20
Qty of Sample Received:	2.5L	**Sample Received On:**	06.10.2020
Sample Mark:	SW-5	**Test Commenced On:**	06.10.2020
Sampling Location:	**Adayar River (Near MIOT Hospital)**	**Test Completed On:**	09.10.2020

S.No	Parameters	Units	Test Method	Results
1	Colour	-	IS 3025 (Part 4) 1983 (RA 2017)	Light Brown
2	Odour	-	IS 3025 (Part 5) 1983 (RA 2017)	Agreeable
3	Turbidity	NTU	IS 3025 (Part 10) 1984 (RA 2017)	43.5
4	pH Value @ 25 °C	-	IS 3025 (Part 11) 1983 (RA 2017)	7.65
5	Temperature	°C	IS 3025 (Part 9) 1984 (RA 2017)	29.5
6	Electrical Conductivity @ 25°C	µS/cm	IS 3025 (Part 14) 1984 (RA 2013)	1954
7	Total Dissolved Solids @ 180°C	mg/l	IS 3025 (Part 16) 1984 (RA 2017)	1066
8	Total Suspended Solids @ 105°C	mg/l	IS 3025 (Part 17) 1984 (RA 2017)	371
9	Bio chemical Oxygen Demand (27°C for 3 days)	mg/l	IS 3025 (Part 44) 1993 (RA 2014)	16.8
10	Chemical Oxygen Demand (COD)	mg/l	IS 3025 (Part 58) 2006 (RA 2017)	64
11	Oil & Grease	mg/l	IS 3025 (Part 39) 1991 (RA 2014)	BDL(DL:5.0)
12	Aluminium (as Al)	mg/l	IS 3025 (Part 55) 2003 (RA 2014)	BDL(DL:0.01)
13	Boron (as B)	mg/l	IS 3025 (Part 57) 2005 (RA 2017)	0.02
14	Calcium (as Ca)	mg/l	IS 3025 (Part 40) 1991 (RA 2014)	101

Verified By

Authorised Signatory

Name: Krishnan G
Designation: Technical Manager

Note: 1.The test results are only to the sample submitted for test. 2.Any Correction of the test report in full or part shall invalidate the report 3.Sample will be retained for 15 days from the date of reporting except in case of regulatory samples or specifically instructed by client. 4.Perishable samples will be discarded immediately after reporting. 5.Under no circumstances lab accepts any liability or loss/damage caused by use or misuse of test report after invoicing or issued of test report

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TEST REPORT

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Report No:	PCEI/TR-W-2673	Report Date:	09.10.2020

S.No	Parameters	Units	Test Method	Results
15	Chlorides (as Cl)	mg/l	IS 3025 (Part 32) 1988 (RA 2003)	297
16	Copper (as Cu)	mg/l	IS 3025 (Part 42) 1992 (RA 2003)	0.28
17	Fluoride (as F)	mg/l	IS 3025 (Part 60) 2008 (RA 2013)	0.82
18	Free Residual Chlorine	mg/l	IS 3025 (Part 26) 1986 (RA 2003)	BDL(DL:0.1)
19	Iron (as Fe)	mg/l	IS 3025 (Part 53) 2003 (RA 2014)	18.3
20	Magnesium (as Mg)	mg/l	IS 3025 (Part 46) 1994 (RA 2003)	35.4
21	Potassium (as K)	mg/l	IS 3025 (Part 45) 1993 (RA 2014)	36.1
22	Silica (as SiO_2)	mg/l	IS 3025 (Part 35) 1988 RA 2014)	1.42
23	Manganese (as Mn)	mg/l	IS 3025 (Part 59) 2006 (RA 2017)	0.61
24	Nitrate (as NO_3)	mg/l	IS 3025 (Part 34) 1988 (RA 2003)	9.03
25	Phenolic Compound (as C_6H_5OH)	mg/l	IS 3025 (Part 43) 1992 (RA 2003)	BDL(DL:0.001)
26	Sulphates (as SO_4^{-2})	mg/l	IS 3025 (Part 24) 1986 (RA 2003)	119.0
27	Total Alkalinity (as $CaCO_3$)	mg/l	IS 3025 (Part 23) 1986 (RA 2003)	399
28	Total Hardness (as $CaCO_3$)	mg/l	IS 3025 (Part 21) 2009 (RA 2014)	398
29	Calcium Hardness	mg/l	IS 3025 (Part 40) 1991 (RA 2014)	252
30	Bicarbonates (as HCO_3)	mg/l	IS 3025 (Part 51) 2001 (RA 2017)	43
31	Zinc (as Zn)	mg/l	IS 3025 (Part 49) 1994 (RA 2003)	0.51
32	Cadmium (as Cd)	mg/l	IS 3025 (Part 41) 1992 (RA 2003)	BDL(DL:0.01)
33	Cyanide (as CN)	mg/l	IS 3025 (Part 27) 1986 (RA 2003)	BDL(DL:0.1)
34	Lead (as Pb)	mg/l	IS 3025 (Part 47) 1994 (RA 2003)	BDL(DL:0.01)
35	Nickel (as Ni)	mg/l	IS 3025 (Part 54) 2003 (RA 2014)	BDL(DL:0.01)
36	Total Arsenic (as As)	mg/l	IS 3025 (Part 37) 1988 (RA 1999)	BDL(DL:0.01)
37	Total Chromium (as Cr)	mg/l	IS 3025 (Part 52) 2003 (RA 2014)	BDL(DL:0.01)

Note: BDL - Below Detection Limit; DL - Detection Limit

..... End of Report .....

Verified By

Authorised Signatory

Name: Krishnan G
Designation: Technical Manager

7-2. Air

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TEST REPORT

AIR MONITORING

Issued to	**M/S. RITES LTD., RITES BHAVAN** ENVIRONMENTAL DIVISION PLOT No 1, SECTOR 29 GURGAON- 122001 HARYANA.
Date of Reporting	27.07.2016.
Analysis No.(Report No).	A600/16-17/R.N1542.
Nature of Sample	AIR SAMPLE.
Issued to	25.07.2016 – 26.07.2016.
Date of Reporting	ALWARTHIRU NAGAR JUNCTION.

RESULTS

SL. NO	PARAMETER	UNIT	OBSERVATION	PERMISSIBLE LIMIT	PROTOCOL/METHOD
1.	Sulphur Dioxide (SO_2)	$\mu g/m^3$	9.58	80	IS 5182 (Part 2):2001 (RA 2012).
2.	Nitrogen Dioxide (NO_2)	$\mu g/m^3$	13.60	80	IS 5182 (Part 6):2006 (RA 2012).
3.	Particulate matter (PM_{10})	$\mu g/m^3$	84.12	100	IS 5182 (Part23):2006 (RA 2012).
4.	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	41.67	60	SOP A02./Based on Instrumental method.
5.	Carbon Monoxide (CO)	mg/m^3	6.0	4.0	IS 5182 (Part10):1999 (RA 2009).

Verified by:

Authorised Signatory

I. KARUPPIAH
Chief Executive

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TEST REPORT

AIR MONITORING

Issued to	**M/S. RITES LTD., RITES BHAVAN** **ENVIRONMENTAL DIVISION** PLOT No 1, SECTOR 29 GURGAON- 122001 HARYANA.
Date of Reporting	27.07.2016.
Analysis No.(Report No).	AS99/16-1/R.N1540.
Nature of Sample	AIR SAMPLE.
Date of Monitoring	25.07.2016 – 26.07.2016.
Location of Monitoring	MIOT HOSPITAL (NEAR RAMAVARAM SIGNAL).

RESULTS

SL. NO	PARAMETER	UNIT	OBSERVATION	PERMISSIBLE LIMIT	PROTOCOL/METHOD
1.	Sulphur Dioxide (SO_2)	$\mu g/m^3$	10.80	80	IS 5182 (Part 2):2001 (RA 2012).
2.	Nitrogen Dioxide (NO_2)	$\mu g/m^3$	15.38	80	IS 5182 (Part 6):2006 (RA 2012).
3.	Particulate matter (PM_{10})	$\mu g/m^3$	73.34	100	IS 5182 (Part23):2006 (RA 2012).
4.	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	33.96	60	SOP A02./Based on Instrumental method.
5.	Carbon Monoxide (CO)	mg/m^3	9.0	4.0	IS 5182 (Part10):1999 (RA 2009).

Verified by:

Authorised Signatory
I. KARUPPIAH
Chief Executive

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TEST REPORT

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Report No	: PCEI/TR-AAQ-4402	**Report Date**	: 16.12.2019.
ULR No	: ULR-TC744619000034LSP		
Issued to	: **M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 5182 (Part 23) 2006 (RA 2017)		
Sampled by	: Laboratory		
Sample Collected Date	: 16.12.2019	**Sample Reference No**	: PCEI/AAQ-N315-12-19
Sample Description	: **Ambient Air**	**Sample Received On**	: 12.12.2019
Qty of Sample Received	: Filter Paper & 30ml	**Test Commenced On**	: 12.12.2019
Sample Condition	: Fit for Analysis	**Test Completed On**	: 16.12.2019
Sampling Location	: **Near Adambakkam MRTS**		

Weather Condition	
Ambient Temperature	: 30°C
Relative Humidity	: 70%
Predominant Wind Direction	: NE-SW
Climate Condition	: Scattered Clouds

S.No	Parameters	Units	Test Method	Results	TNPCB Max. Permissible Limits of NAAQ Standards for Industrial Area (TWA for 24 Hrs)
1	Sulphur dioxide (as SO_2)	$\mu g/m^3$	IS 5182 (Part 2) 2001 (RA 2017)	16.4	80
2	Oxides of Nitrogen (as NO_x)	$\mu g/m^3$	IS 5182 (Part 6) 2006 (RA 2017)	28.1	80
3	Respirable Particulate Matter (PM_{10})	$\mu g/m^3$	IS 5182 (Part 23) 2006 (RA 2017)	61.6	100
4	Respirable Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	NAAQMS/36/2012-13 (Volume 1)	34.9	60
5	Carbon Monoxide (as CO)	mg/m^3	IS 5182 (Part 10) 1999 (RA 2014)	BDL(DL:1.2)	4*

Note: i) NAAQS - National Ambient Air Quality Standards Issued by CPCB (Central Pollution Control Board) in Nov 2009
ii) TWA - Time Weighted Average iii) *- TWA for 1 Hour iv) ** - TWA for Annual
BDL - Below Detection Limit ; DL - Detection Limit

..... End of Report .....
Page 1 of 1

Verified By

Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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TEST REPORT

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Report No	: PCEI/TR/AAQ-4403	**Report Date**	: 16.12.2019
ULR No	: ULR-TC744619000341 6P		
Issued to	: **M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 5182 (Part 23) 2006 (RA 2017)		
Sampled by	: Laboratory		
Sample Collected Date	: 11.12.2019	**Sample Reference No**	: PCEI/AAQ-N016-12-19
Sample Description	: **Ambient Air**	**Sample Received On**	: 12.12.2019
Qty of Sample Received	: Filter Paper & 30ml	**Test Commenced On**	: 12.12.2019
Sample Condition	: Fit for Analysis	**Test Completed On**	: 16.12.2019
Sampling Location	: **Madipakkam Koot Road Junction**		

Weather Condition	
Ambient Temperature	: 30°C
Relative Humidity	: 75%
Predominent Wind Direction	: NE-SW
Climate Condition	: Scattered Clouds

S.No	Parameters	Units	Test Method	Results	TNPCB Max. Permissible Limits of NAAQ Standards for Industrial Area (TWA for 24 Hrs)
1	Sulphur dioxide (as SO_2)	$\mu g/m^3$	IS 5182 (Part 2) 2001 (RA 2017)	14.3	80
2	Oxides of Nitrogen (as NO_x)	$\mu g/m^3$	IS 5182 (Part 6) 2006 (RA 2017)	29.6	80
3	Respirable Particulate Matter (PM_{10})	$\mu g/m^3$	IS 5182 (Part 23) 2006 (RA 2017)	63.2	100
4	Respirable Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	NAAQMS/36/2012-13 (Volume 1)	31.9	60
5	Carbon Monoxide (as CO)	mg/m^3	IS 5182 (Part 10) 1999 (RA 2014)	BDL(DL:1.2)	4*

Note: i) NAAQS - National Ambient Air Quality Standards Issued by CPCB (Central Pollution Control Board) in Nov 2009
ii) TWA - Time Weighted Average iii) *- TWA for 1 Hour iv) ** - TWA for Annual
BDL - Below Detection Limit ; DL - Detection Limit

..... End of Report .....

Verified By

Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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Report No	: PCEI/TR-AAQ-4404	**Report Date**	:16.12.2019.
ULR No	: ULR-TC744619000341 7P		
Issued to	: **M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: IS 5182 (Part 23) 2006 (RA 2017)		
Sampled by	: Laboratory		
Sample Collected Date	: 11.12.2019	**Sample Reference No**	: PCEI/AAQ-N317-12-19
Sample Description	: **Ambient Air**	**Sample Received On**	: 12.12.2019
Qty of Sample Received	: Filter Paper & 30ml	**Test Commenced On**	: 12.12.2019
Sample Condition	: Fit for Analysis	**Test Completed On**	: 16.12.2019
Sampling Location	: **Vallakal Bus Stop**		

Weather Condition	
Ambient Temperature	: 31°C
Relative Humidity	: 66%
Predominent Wind Direction	: NE-SW
Climate Condition	: Scattered Clouds

S.No	Parameters	Units	Test Method	Results	TNPCB Max. Permissible Limits of NAAQ Standards for Industrial Area (TWA for 24 Hrs)
1	Sulphur dioxide (as SO_2)	µg/m³	IS 5182 (Part 2) 2001 (RA 2017)	18.9	80
2	Oxides of Nitrogen (as NO_x)	µg/m³	IS 5182 (Part 6) 2006 (RA 2017)	25.7	80
3	Respirable Particulate Matter (PM_{10})	µg/m³	IS 5182 (Part 23) 2006 (RA 2017)	61.1	100
4	Respirable Particulate Matter ($PM_{2.5}$)	µg/m³	NAAQMS/36/2012-13 (Volume 1)	35.3	60
5	Carbon Monoxide (as CO)	mg/m³	IS 5182 (Part 10) 1999 (RA 2014)	BDL(DL:1.2)	4*

Note: i) NAAQS - National Ambient Air Quality Standards Issued by CPCB (Central Pollution Control Board) in Nov 2009
ii) TWA - Time Weighted Average iii) *- TWA for 1 Hour iv) ** - TWA for Annual
BDL - Below Detection Limit ; DL - Detection Limit

..... End of Report .....

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Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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TEST REPORT

AIR MONITORING

Issued to	**M/S. RITES LTD., RITES BHAVAN ENVIRONMENTAL DIVISION** PLOT No 1, SECTOR 29 GURGAON- 122001 HARYANA.
Date of Reporting	05.08.2016.
Analysis No.(Report No).	A620/16-17/R.N1582
Nature of Sample	AIR SAMPLE.
Date of Monitoring	03.08.2016-04.08.2016.
Location of Monitoring	MEDAVAKKAM JUNCTION (Opp.to canara Bank)

RESULTS

Sl. NO	PARAMETER	UNIT	OBSERVATION	PERMISSIBLE LIMIT	PROTOCOL/METHOD
1.	Sulphur Dioxide (SO_2)	$\mu g/m^3$	8.82	80	IS 5182 (Part 2):2001 (RA 2012).
2.	Nitrogen Dioxide (NO_2)	$\mu g/m^3$	9.35	80	IS 5182 (Part 6):2006 (RA 2012).
3.	Particulate matter (PM_{10})	$\mu g/m^3$	69.97	100	IS 5182 (Part23):2006 (RA 2012).
4.	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	25.14	60	SOP A02./Based on Instrumental method.
5.	Carbon Monoxide (CO)	mg/m^3	6.0	4.0	IS 5182 (Part10):1999 (RA.2009).

Verified by:

Authorised Signatory
I. KARUPPIAH
Chief Executive

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TEST REPORT

AIR MONITORING

Issued to	**M/S. RITES LTD., RITES BHAVAN ENVIRONMENTAL DIVISION** PLOT No 1, SECTOR 29 GURGAON- 122001 HARYANA.
Date of Reporting	04.08.2016.
Analysis No.(Report No).	A618/16-17/R.N1578
Nature of Sample	AIR SAMPLE
Date of Monitoring	02.08.2016 – 03.08.2016
Location of Monitoring	GLOBAL HOSPITAL (Indira priyadarshini Nagar)

RESULTS

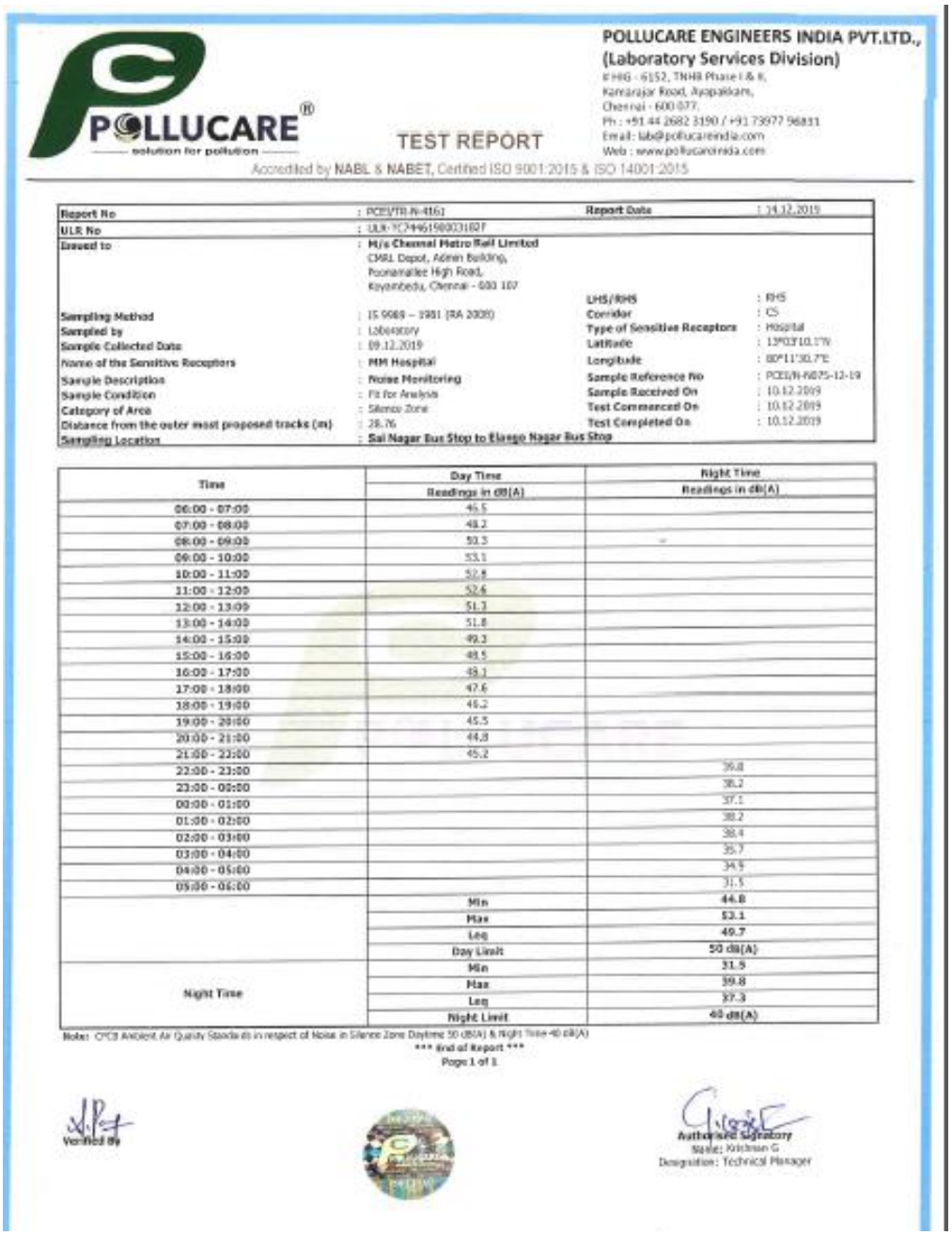
SL. NO	PARAMETER	UNIT	OBSERVATION	PERMISSIBLE LIMIT	PROTOCOL/METHOD
1.	Sulphur Dioxide (SO_2)	$\mu g/m^3$	6.23	80	IS 5182 (Part 2):2001 (RA 2012).
2.	Nitrogen Dioxide (NO_2)	$\mu g/m^3$	9.48	80	IS 5182 (Part 6):2006 (RA 2012).
3.	Particulate matter (PM_{10})	$\mu g/m^3$	62.37	100	IS 5182 (Part23):2006 (RA 2012).
4.	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	29.16	60	SOP A02./Based on Instrumental method.
5.	Carbon Monoxide (CO)	mg/m^3	4.0	4.0	IS 5182 (Part10):1999 (RA.2009).

Verified by:

Authorised Signatory

I. KARUPPIAH
Chief Executive

7-3. Noise



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Accredited by NABL & NABET, Certified ISO 9001:2015 & ISO 14001:2015

Report No	: PCEI/TR-N-4161	**Report Date**	: 14.12.2019
ULR No	: ULR-TC744619000316TF		
Issued to	: **M/s Chennai Metro Rail Limited** CMRL Depot, Admn Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
		LHS/RHS	: RHS
Sampling Method	: IS 9989 – 1981 (RA 2008)	**Corridor**	: CS
Sampled by	: Laboratory	**Type of Sensitive Receptors**	: Hospital
Sample Collected Date	: 09.12.2019	**Latitude**	: 13°03'10.1"N
Name of the Sensitive Receptors	: **MM Hospital**	**Longitude**	: 80°11'30.7"E
Sample Description	: **Noise Monitoring**	**Sample Reference No**	: PCEI/N-N075-12-19
Sample Condition	: Fit for Analysis	**Sample Received On**	: 10.12.2019
Category of Area	: Silence Zone	**Test Commenced On**	: 10.12.2019
Distance from the outer most proposed tracks (m)	: 28.76	**Test Completed On**	: 10.12.2019
Sampling Location	: **Sai Nagar Bus Stop to Elango Nagar Bus Stop**		

Time	Day Time Readings in dB(A)	Night Time Readings in dB(A)
06:00 - 07:00	46.5	
07:00 - 08:00	48.2	
08:00 - 09:00	50.5	
09:00 - 10:00	53.1	
10:00 - 11:00	52.8	
11:00 - 12:00	52.6	
12:00 - 13:00	51.3	
13:00 - 14:00	51.8	
14:00 - 15:00	49.3	
15:00 - 16:00	48.5	
16:00 - 17:00	48.1	
17:00 - 18:00	47.6	
18:00 - 19:00	46.2	
19:00 - 20:00	45.5	
20:00 - 21:00	44.8	
21:00 - 22:00	45.2	
22:00 - 23:00		39.8
23:00 - 00:00		38.2
00:00 - 01:00		37.1
01:00 - 02:00		38.2
02:00 - 03:00		38.4
03:00 - 04:00		35.7
04:00 - 05:00		34.9
05:00 - 06:00		31.5
	Min	**44.8**
	Max	**53.1**
	Leq	**49.7**
	Day Limit	**50 dB(A)**
Night Time	**Min**	**31.5**
	Max	**39.8**
	Leq	**37.3**
	Night Limit	**40 dB(A)**

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

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Verified By

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Name: Krishnan G
Designation: Technical Manager

ENTREAT

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TEST REPORT

NOISE MONITORING

Issued to	**M/S. RITES LTD., RITES BHAVAN** ENVIRONMENTAL DIVISION PLOT No 1, SECTOR 29 GURGAON- 122001 HARYANA.
Report No & Date.	1541/16-17 dt 27.07.2016.
Period of Monitoring	25.07.2016 – 26.07.2016.
Location of Monitoring	ALWARTHIRU NAGAR JUNCTION.

RESULTS

S. No.	Monitoring Duration	Hourly Leq, dB(A)	S. No.	Monitoring Duration	Hourly Leq, dB(A)
1.	06:00 to 07:00	72.97	13.	18:00 to 19:00	79.88
2.	07:00 to 08:00	74.77	14.	19:00 to 20:00	77.12
3.	08:00 to 09:00	75.42	15.	20:00 to 21:00	74.87
4.	09:00 to 10:00	78.47	16.	21:00 to 22:00	69.26
5.	10:00 to 11:00	78.67	17.	22:00 to 23:00	61.26
6.	11:00 to 12:00	79.25	18.	23:00 to 24:00	63.17
7.	12:00 to 13:00	79.52	19.	24:00 to 01:00	64.96
8.	13:00 to 14:00	80.11	20.	01:00 to 02:00	62.65
9.	14:00 to 15:00	79.49	21.	02:00 to 03:00	69.03
10.	15:00 to 16:00	80.90	22.	03:00 to 04:00	71.04
11.	16:00 to 17:00	81.60	23.	04:00 to 05:00	71.16
12.	17:00 to 18:00	80.20	24.	05:00 to 06:00	69.58

OVERALL RESULT

L_{eq}	L_{10}	L_{50}	L_{90}	L_{max}	L_{min}	L_{day}	L_{night}	L_{dn}
81.19	80.55	76.27	63.35	81.60	61.26	77.66	66.61	72.13

PERMISSIBLE LIMIT: AMBIENT NOISE STANDARDS as per THE NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000

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

Verified by :

Authorised Signatory

I. KARUPPIAH
Chief Executive

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TEST REPORT

Accredited by NABL & NABET, Certified ISO 9001:2015 & ISO 14001:2015

Report No	: PCEI/TR-N-4165	**Report Date**	: 14.12.2019
ULR No	: ULR-TC744619000319F		
Issued to	: **M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
		LHS/RHS	: U/S
Sampling Method	: IS 9989 – 1981 (RA 2008)	**Corridor**	: C5
Sampled by	: Laboratory	**Type of Sensitive Receptors**	: Hospital
Sample Collected Date	: 11.12.2019	**Latitude**	: 13°01'59.2"N
Name of the Sensitive Receptors	: **DMS St. Joseph Hospital**	**Longitude**	: 80°09'40.0"E
Sample Description	: **Noise Monitoring**	**Sample Reference No**	: PCEI/N-N079-12-19
Sample Condition	: Fit for Analysis	**Sample Received On**	: 12.12.2019
Category of Area	: Silence Zone	**Test Commenced On**	: 12.12.2019
Distance from the outer most proposed tracks (m)	: 52.93	**Test Completed On**	: 12.12.2019
Sampling Location	: **Porur to Mugalivakkam**		

Time	Day Time Readings in dB(A)	Night Time Readings in dB(A)
06:00 - 07:00	47.2	
07:00 - 08:00	48.2	
08:00 - 09:00	49.3	
09:00 - 10:00	50.8	
10:00 - 11:00	50.9	
11:00 - 12:00	51.3	
12:00 - 13:00	50.0	
13:00 - 14:00	47.8	
14:00 - 15:00	48.1	
15:00 - 16:00	49.2	
16:00 - 17:00	48.2	
17:00 - 18:00	47.6	
18:00 - 19:00	47.0	
19:00 - 20:00	46.8	
20:00 - 21:00	45.6	
21:00 - 22:00	45.0	
22:00 - 23:00		41.9
23:00 - 00:00		39.5
00:00 - 01:00		34.7
01:00 - 02:00		36.2
02:00 - 03:00		37.8
03:00 - 04:00		36.5
04:00 - 05:00		35.2
05:00 - 06:00		37.1
	Min	**45.0**
	Max	**51.3**
	Leq	**48.7**
	Day Limit	**50 dB(A)**
Night Time	**Min**	**34.7**
	Max	**41.9**
	Leq	**38.2**
	Night Limit	**40 dB(A)**

Notes: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1

Verified By

Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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TEST REPORT

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Report No	: PCEI/TR-R-4164	**Report Date**	: 14.12.2019
ULR No	: ULR-TC244619000031857		
Issued to	: **M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
		LHS/RHS	: U-S
Sampling Method	: IS 9989 – 1981 (RA 2008)	**Corridor**	: CS
Sampled by	: Laboratory	**Type of Sensitive Receptors**	: School
Sample Collected Date	: 11.12.2019	**Latitude**	: 13°02'01.8"N
Name of the Sensitive Receptors	: **Government Boys School**	**Longitude**	: 80°09'36.0"E
Sample Description	: **Noise Monitoring**	**Sample Reference No**	: PCEI/N-N078-12-19
Sample Condition	: Fit for Analysis	**Sample Received On**	: 12.12.2019
Category of Area	: Silence Zone	**Test Commenced On**	: 12.12.2019
Distance from the outer most proposed tracks (m)	: 46.03	**Test Completed On**	: 12.12.2019
Sampling Location	: **Porur to Mugalivakkam**		

Time	Day Time Readings in dB(A)	Night Time Readings in dB(A)
06:00 - 07:00	48.2	
07:00 - 08:00	49.5	
08:00 - 09:00	56.1	
09:00 - 10:00	59.8	
10:00 - 11:00	56.5	
11:00 - 12:00	53.2	
12:00 - 13:00	54.8	
13:00 - 14:00	60.6	
14:00 - 15:00	58.1	
15:00 - 16:00	53.4	
16:00 - 17:00	52.7	
17:00 - 18:00	50.9	
18:00 - 19:00	48.2	
19:00 - 20:00	47.3	
20:00 - 21:00	46.0	
21:00 - 22:00	45.2	
22:00 - 23:00		39.8
23:00 - 00:00		37.6
00:00 - 01:00		37.1
01:00 - 02:00		36.5
02:00 - 03:00		34.5
03:00 - 04:00		33.7
04:00 - 05:00		33.1
05:00 - 06:00		34.6
	Min	**45.2**
	Max	**60.6**
	Leq	**54.9**
	Day Limit	**50 dB(A)**
Night Time	**Min**	**33.1**
	Max	**39.8**
	Leq	**36.4**
	Night Limit	**40 dB(A)**

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

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Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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TEST REPORT

NOISE MONITORING

Issued to	M/S. RITES LTD., RITES BHAVAN ENVIRONMENTAL DIVISION PLOT No 1, SECTOR 29 GURGAON- 122001 HARYANA.
Report No & Date.	1539/16-17 dt 27.07.2016.
Period of Monitoring	25.07.2016 – 26.07.2016.
Location of Monitoring	MIOT HOSPITAL (NEAR RAMAVARAM SIGNAL)

RESULTS

S. No.	Monitoring Duration	Hourly Leq, dB(A)	S. No.	Monitoring Duration	Hourly Leq, dB(A)
1.	06:00 to 07:00	72.39	13.	18:00 to 19:00	75.84
2.	07:00 to 08:00	80.03	14.	19:00 to 20:00	77.59
3.	08:00 to 09:00	79.91	15.	20:00 to 21:00	78.16
4.	09:00 to 10:00	78.00	16.	21:00 to 22:00	75.10
5.	10:00 to 11:00	77.36	17.	22:00 to 23:00	77.45
6.	11:00 to 12:00	77.17	18.	23:00 to 24:00	75.73
7.	12:00 to 13:00	76.36	19.	24:00 to 01:00	72.99
8.	13:00 to 14:00	75.50	20.	01:00 to 02:00	73.80
9.	14:00 to 15:00	75.43	21.	02:00 to 03:00	75.23
10.	15:00 to 16:00	74.46	22.	03:00 to 04:00	70.22
11.	16:00 to 17:00	73.66	23.	04:00 to 05:00	70.35
12.	17:00 to 18:00	75.29	24.	05:00 to 06:00	70.00

OVERALL RESULT

Leq	L_{10}	L_{50}	L_{90}	L_{max}	L_{min}	L_{day}	L_{night}	L_{dn}
76.78	79.04	75.47	70.16	79.91	70.00	76.39	73.22	74.80

PERMISSIBLE LIMIT: AMBIENT NOISE STANDARDS as per THE NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000

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

Verified by:

Authorised Signatory

P. KARUPPIAH
Chief Executive

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TEST REPORT

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Report No	: POE/TR-N-4862	**Report Date**	: 14.12.2019
ULR No	: ULR-TC744610860311OF		
Issued to	: **M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
		LHS/RHS	: RHS
Sampling Method	: IS 9989 – 1981 (RA 2008)	**Corridor**	: CS
Sampled by	: Laboratory	**Type of Sensitive Receptors**	: College
Sample Collected Date	: 10.12.2019	**Latitude**	: 13°00'48.9"N
Name of the Sensitive Receptors	: **St. Joseph College**	**Longitude**	: 80°11'37.2"E
Sample Description	: **Noise Monitoring**	**Sample Reference No**	: POE/N-4876-12-19
Sample Condition	: Fit for Analysis	**Sample Received On**	: 11.12.2019
Category of Area	: Silence Zone	**Test Commenced On**	: 11.12.2019
Distance from the outer most proposed tracks (m)	: 35.00	**Test Completed On**	: 11.12.2019
Sampling Location	: **CTC to St. Wesley Church**		

Time		Day Time Readings in dB(A)	Night Time Readings in dB(A)
06:00 - 07:00		46.8	
07:00 - 08:00		48.2	
08:00 - 09:00		55.1	
09:00 - 10:00		58.4	
10:00 - 11:00		59.8	
11:00 - 12:00		52.3	
12:00 - 13:00		50.8	
13:00 - 14:00		57.6	
14:00 - 15:00		53.5	
15:00 - 16:00		50.0	
16:00 - 17:00		57.8	
17:00 - 18:00		59.1	
18:00 - 19:00		47.6	
19:00 - 20:00		46.8	
20:00 - 21:00		45.8	
21:00 - 22:00		44.3	
22:00 - 23:00			38.3
23:00 - 00:00			37.2
00:00 - 01:00			37.3
01:00 - 02:00			36.5
02:00 - 03:00			35.1
03:00 - 04:00			34.4
04:00 - 05:00			33.5
05:00 - 06:00			35.2
	Min		**44.3**
	Max		**59.8**
	Leq		**54.8**
	Day Limit		**50 dB(A)**
Night Time	**Min**		**33.5**
	Max		**38.3**
	Leq		**36.2**
	Night Limit		**40 dB(A)**

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Verified By

Authorised Signatory
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Designation: Technical Manager

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TEST REPORT

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Report No	: PCEI/TR-N-4168	Report Date	: 14.12.2019
ULR No	: ULR-TC749615000319F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
		LHS/RHS	: LHS
Sampling Method	: IS 9989 – 1981 (RA 2008)	Corridor	: CS
Sampled by	: Laboratory	Type of Sensitive Receptors	: School
Sample Collected Date	: 12.12.2019	Latitude	: 13°00'46.5"N
Name of the Sensitive Receptors	: Contonement Board High School	Longitude	: 80°11'43.3"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-4082-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 13.12.2019
Category of Area	: Silence Zone	Test Commenced On	: 13.12.2019
Distance from the outer most proposed tracks (m)	: 77.93	Test Completed On	: 13.12.2019
Sampling Location	: CTC to St. Wesley Church		

Time	Day Time Readings in dB(A)	Night Time Readings in dB(A)
06:00 - 07:00	40.8	
07:00 - 08:00	41.6	
08:00 - 09:00	42.8	
09:00 - 10:00	44.1	
10:00 - 11:00	45.8	
11:00 - 12:00	47.3	
12:00 - 13:00	49.8	
13:00 - 14:00	46.1	
14:00 - 15:00	47.5	
15:00 - 16:00	48.2	
16:00 - 17:00	43.5	
17:00 - 18:00	40.6	
18:00 - 19:00	44.0	
19:00 - 20:00	43.2	
20:00 - 21:00	42.1	
21:00 - 22:00	40.6	
22:00 - 23:00		34.9
23:00 - 00:00		34.5
00:00 - 01:00		34.8
01:00 - 02:00		36.2
02:00 - 03:00		35.7
03:00 - 04:00		33.1
04:00 - 05:00		34.6
05:00 - 06:00		35.8
	Min	40.6
	Max	49.8
	Leq	45.2
	Day Limit	50 dB(A)
Night Time	Min	33.1
	Max	36.2
	Leq	34.8
	Night Limit	40 d B(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Verified By

Authorised Signatory
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Designation: Technical Manager

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TEST REPORT

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Report No	: PCEI/TR-N-4167	Report Date	: 14.12.2019
ULR No	: ULR-TC446190003188F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
		LHS/RHS	: LHS
Sampling Method	: IS 9989 – 1981 (RA 2008)	Corridor	: C5
Sampled by	: Laboratory	Type of Sensitive Receptors	: School
Sample Collected Date	: 12.12.2019	Latitude	: 13°00'32.3"N
Name of the Sensitive Receptors	: National Matric. Hr. Sec. School	Longitude	: 80°12'14.7"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N081-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 13.12.2019
Category of Area	: Silence Zone	Test Commenced On	: 13.12.2019
Distance from the outer most proposed tracks (m)	: 56.00	Test Completed On	: 13.12.2019
Sampling Location	: St. Wesley Church to Alandur		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	48.2	
07:00 - 08:00	46.2	
08:00 - 09:00	47.6	
09:00 - 10:00	49.5	
10:00 - 11:00	51.6	
11:00 - 12:00	53.6	
12:00 - 13:00	54.9	
13:00 - 14:00	53.8	
14:00 - 15:00	55.0	
15:00 - 16:00	53.1	
16:00 - 17:00	52.9	
17:00 - 18:00	50.6	
18:00 - 19:00	48.6	
19:00 - 20:00	47.2	
20:00 - 21:00	46.0	
21:00 - 22:00	45.3	
22:00 - 23:00		41.6
23:00 - 00:00		43.0
00:00 - 01:00		39.7
01:00 - 02:00		38.4
02:00 - 03:00		38.4
03:00 - 04:00		38.6
04:00 - 05:00		35.1
05:00 - 06:00		33.9
	Min	45.3
	Max	55.0
	Leq	51.4
	Day Limit	50 dB(A)
Night Time	Min	33.9
	Max	41.6
	Leq	38.7
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1

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TEST REPORT

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Report No	: PCEI/TR-N-4158	Report Date	: 14.12.2019
ULR No	: ULR-TC744819000E179F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
		LHS/RHS	: LHS
Sampling Method	: IS 9989 – 1981 (RA 2008)	Corridor	: CS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Hospital
Sample Collected Date	: 07.12.2019	Latitude	: 12°58'57.4"N
Name of the Sensitive Receptors	: Kalpana Hospital	Long Rede	: 80°11'46.3"E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-N072-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 08.12.2019
Catagory of Area	: Silence Zone	Test Commenced On	: 08.12.2019
Distance from the outer most proposed tracks (m)	: 1.00	Test Completed On	: 08.12.2019
Sampling Location	: Adambakkam MRTS to Medavakkam Main Road		

Time	Day Time	Night Time
	Readings in dB(A)	Readings in dB(A)
06:00 - 07:00	53.6	
07:00 - 08:00	54.1	
08:00 - 09:00	56.9	
09:00 - 10:00	57.4	
10:00 - 11:00	57.3	
11:00 - 12:00	52.1	
12:00 - 13:00	56.8	
13:00 - 14:00	54.7	
14:00 - 15:00	55.1	
15:00 - 16:00	52.9	
16:00 - 17:00	51.5	
17:00 - 18:00	50.8	
18:00 - 19:00	51.3	
19:00 - 20:00	55.7	
20:00 - 21:00	56.1	
21:00 - 22:00	53.4	
22:00 - 23:00		37.8
23:00 - 00:00		36.6
00:00 - 01:00		35.2
01:00 - 02:00		34.2
02:00 - 03:00		33.8
03:00 - 04:00		33.1
04:00 - 05:00		32.1
05:00 - 06:00		33.9
Day Time	Min	50.8
	Max	57.4
	Leq	54.8
	Day Limit	50 dB(A)
Night Time	Min	32.1
	Max	37.8
	Leq	35.0
	Night Limit	40 d B(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Verified By

Authorised Signatory
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Designation: Technical Manager

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TEST REPORT

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Report No	: PCEI/TR-N-4560	Report Date	: 14.12.2019
ULR No	: ULR-TC744615000E3181F		
Issued to	: M/s Chennai Metro Rail Limited CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
		LHS/RHS	: RHS
Sampling Method	: IS 9989 – 1981 (RA 2008)	Corridor	: CS
Sampled by	: Laboratory	Type of Sensitive Receptors	: Temple
Sample Collected Date	: 09.12.2019	Latitude	: 12° 55' 52.2768" N
Name of the Sensitive Receptors	: Sri Varasidhi Vinayagar Koil	Longitude	: 80°10'54.2" E
Sample Description	: Noise Monitoring	Sample Reference No	: PCEI/N-4074-12-19
Sample Condition	: Fit for Analysis	Sample Received On	: 10.12.2019
Category of Area	: Silence Zone	Test Commenced On	: 10.12.2019
Distance from the outer most proposed tracks (m)	: 23.05	Test Completed On	: 10.12.2019
Sampling Location	: Madipakkam Kootr Road Bus Stop to Venkateswara Nagar		

Time	Day Time Readings in dB(A)	Night Time Readingsis dB(A)
06:00 - 07:00	46.8	
07:00 - 08:00	47.3	
08:00 - 09:00	49.5	
09:00 - 10:00	48.2	
10:00 - 11:00	47.9	
11:00 - 12:00	42.6	
12:00 - 13:00	43.4	
13:00 - 14:00	46.9	
14:00 - 15:00	45.7	
15:00 - 16:00	49.4	
16:00 - 17:00	48.6	
17:00 - 18:00	49.4	
18:00 - 19:00	48.3	
19:00 - 20:00	47.0	
20:00 - 21:00	46.5	
21:00 - 22:00	45.2	
22:00 - 23:00		38.4
23:00 - 00:00		35.9
00:00 - 01:00		34.3
01:00 - 02:00		33.6
02:00 - 03:00		35.8
03:00 - 04:00		32.3
04:00 - 05:00		31.7
05:00 - 06:00		34.9
	Min	42.6
	Max	49.5
	Leq	47.4
	Day Limit	50 dB(A)
Night Time	Min	31.6
	Max	38.4
	Leq	35.0
	Night Limit	40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1

Verified By

Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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TEST REPORT

Accredited by NABL & NABET, Certified ISO 9001:2015 & ISO 14001:2015

Report No	: PCEI/TR-N-4159	**Report Date**	: 14.12.2019
ULR No	: ULR-TC749615000318OF		
Issued to	: **M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
		LHS/RHS	: LHS
Sampling Method	: IS 9989 – 1981 (RA 2001)	**Corridor**	: CS
Sampled by	: Laboratory	**Type of Sensitive Receptors**	: Hospital
Sample Collected Date	: 07.12.2019	**Latitude**	: 13°57'50.17"N
Name of the Sensitive Receptors	: **Anjakka Hospital**	**Longitude**	: 80°11'16.5"E
Sample Description	: **Noise Monitoring**	**Sample Reference No**	: PCEI/N-M073-12-19
Sample Condition	: Fit for Analysis	**Sample Received On**	: 08.12.2019
Category of Area	: Silence Zone	**Test Commenced On**	: 08.12.2019
Distance from the outer most proposed tracks (m)	: 11.00	**Test Completed On**	: 09.12.2019
Sampling Location	: **Madipakkam Koot Road Bus Stop to Venkateswara Nagar**		

Time	Day Time Readings in dB(A)	Night Time Readings in dB(A)
06:00 - 07:00	43.8	
07:00 - 08:00	43.7	
08:00 - 09:00	43.3	
09:00 - 10:00	43.1	
10:00 - 11:00	43.4	
11:00 - 12:00	44.2	
12:00 - 13:00	45.6	
13:00 - 14:00	45.8	
14:00 - 15:00	45.4	
15:00 - 16:00	44.1	
16:00 - 17:00	43.5	
17:00 - 18:00	43.2	
18:00 - 19:00	40.8	
19:00 - 20:00	39.2	
20:00 - 21:00	39.5	
21:00 - 22:00	38.3	
22:00 - 23:00		36.5
23:00 - 00:00		36.5
00:00 - 01:00		34.5
01:00 - 02:00		33.7
02:00 - 03:00		33.1
03:00 - 04:00		34.6
04:00 - 05:00		34.2
05:00 - 06:00		34.1
Day Time	Min	38.3
	Max	45.8
	Leq	42.8
	Day Limit	50 dB(A)
Night Time	Min	33.1
	Max	38.5
	Leq	35.3
	Night Limit	40 dB(A)

Notes: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Page 1 of 1

Verified By

Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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Web : www.pollucareindia.com

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TEST REPORT

Accredited by NABL & NABET. Certified ISO 9001:2015 & ISO 14001:2015

Report No	: PCEI/TR-N-4163	**Report Date**	: 14.12.2019
ULR No	: ULR-TC744619000318AF		
Issued to	: **M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
		LHS/RHS	: LHS
Sampling Method	: IS 9989 - 1981 (RA 2008)	**Corridor**	: CS
Sampled by	: Laboratory	**Type of Sensitive Receptors**	: School
Sample Collected Date	: 10.12.2019	**Latitude**	: 12°57'06.1"N
Name of the Sensitive Receptors	: **Ravindra Bharti Global School**	**Longitude**	: 80°11'08.5"E
Sample Description	: **Noise Monitoring**	**Sample Reference No**	: PCEI/N-N077-12-19
Sample Condition	: Fit for Analysis	**Sample Received On**	: 11.12.2019
Category of Area	: Silence Zone	**Test Commenced On**	: 11.12.2019
Distance from the outer most proposed tracks (m)	: 42.64	**Test Completed On**	: 11.12.2019
Sampling Location	: **Venkateswara Nagar - Echankadu Bus Stop**		

Time		Day Time	Night Time
		Readings in dB(A)	Readings in dB(A)
06:00 - 07:00		40.3	
07:00 - 08:00		43.6	
08:00 - 09:00		49.8	
09:00 - 10:00		54.1	
10:00 - 11:00		58.6	
11:00 - 12:00		49.3	
12:00 - 13:00		41.4	
13:00 - 14:00		53.7	
14:00 - 15:00		56.5	
15:00 - 16:00		51.9	
16:00 - 17:00		58.7	
17:00 - 18:00		60.3	
18:00 - 19:00		53.1	
19:00 - 20:00		50.8	
20:00 - 21:00		49.6	
21:00 - 22:00		44.3	
22:00 - 23:00			37.8
23:00 - 00:00			35.2
00:00 - 01:00			34.2
01:00 - 02:00			33.8
02:00 - 03:00			33.1
03:00 - 04:00			32.1
04:00 - 05:00			33.4
05:00 - 06:00			34.6
	Min		40.3
	Max		60.3
	Leq		54.3
	Day Limit		50 dB(A)
Night Time	Min		32.1
	Max		37.8
	Leq		34.6
	Night Limit		40 dB(A)

Note: CPCB Ambient Air Quality Standards in respect of Noise in Silence Zone Daytime 50 dB(A) & Night Time 40 dB(A)

*** End of Report ***

Verified By

Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

ENTREAT

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Phone : 23765636 Telefax : 23764641 Mobile : 98400 39553 E-Mail : entreatlab@yahoo.co.in

TEST REPORT

NOISE MONITORING

Issued to	**M/S. RITES LTD., RITES BHAVAN** ENVIRONMENTAL DIVISION PLOT No 1, SECTOR 29 GURGAON- 122001 HARYANA.
Report No & Date.	1581/16-17 dt 05.08.2016.
Period of Monitoring	03.08.2016-04.08.2016.
Location of Monitoring	MEDAVAKKAM JUNCTION (Opp.to canara Bank)

RESULTS

S. No.	Monitoring Duration	Hourly Leq, dB(A)	S. No.	Monitoring Duration	Hourly Leq, dB(A)
1.	06:00 to 07:00	72.05	13.	18:00 to 19:00	68.49
2.	07:00 to 08:00	71.10	14.	19:00 to 20:00	68.75
3.	08:00 to 09:00	70.41	15.	20:00 to 21:00	65.66
4.	09:00 to 10:00	72.34	16.	21:00 to 22:00	62.60
5.	10:00 to 11:00	70.48	17.	22:00 to 23:00	58.70
6.	11:00 to 12:00	72.37	18.	23:00 to 24:00	57.31
7.	12:00 to 13:00	73.79	19.	24:00 to 01:00	56.49
8.	13:00 to 14:00	66.70	20.	01:00 to 02:00	58.70
9.	14:00 to 15:00	62.29	21.	02:00 to 03:00	65.15
10.	15:00 to 16:00	72.81	22.	03:00 to 04:00	59.20
11.	16:00 to 17:00	69.69	23.	04:00 to 05:00	64.64
12.	17:00 to 18:00	70.32	24.	05:00 to 06:00	67.08

OVERALL RESULT

Leq	L_{10}	L_{50}	L_{90}	L_{max}	L_{min}	L_{day}	L_{night}	L_{DN}
71.00	72.59	67.78	58.70	73.79	56.49	69.37	60.91	65.14

PERMISSIBLE LIMIT: AMBIENT NOISE STANDARDS as per THE NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000

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

Verified by:

Authorised Signatory

"SAVE ENVIRONMENT"

ENTREAT

ENTREAT LABORATORIES

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Phone : 23765636 Telefax : 23764641 Mobile : 98400 39553 E-Mail : entreatlab@yahoo.co.in

TEST REPORT

NOISE MONITORING

Issued to	M/S. RITES LTD., RITES BHAVAN ENVIRONMENTAL DIVISION PLOT No 1, SECTOR 29 GURGAON- 122001 HARYANA.
Report No & Date.	1577/16-17 dt 04.08.2016.
Period of Monitoring	02.08.2016 - 03.08.2016
Location of Monitoring	GLOBAL HOSPITAL (Indira priyadarshini Nagar)

RESULTS

S. No.	Monitoring Duration	Hourly Leq, dB(A)	S. No.	Monitoring Duration	Hourly Leq, dB(A)
1.	06:00 to 07:00	69.70	13.	18:00 to 19:00	61.80
2.	07:00 to 08:00	73.48	14.	19:00 to 20:00	61.23
3.	08:00 to 09:00	71.88	15.	20:00 to 21:00	60.28
4.	09:00 to 10:00	68.05	16.	21:00 to 22:00	61.32
5.	10:00 to 11:00	62.57	17.	22:00 to 23:00	64.05
6.	11:00 to 12:00	69.99	18.	23:00 to 24:00	59.51
7.	12:00 to 13:00	68.55	19.	24:00 to 01:00	57.25
8.	13:00 to 14:00	64.28	20.	01:00 to 02:00	57.39
9.	14:00 to 15:00	80.68	21.	02:00 to 03:00	62.17
10.	15:00 to 16:00	63.13	22.	03:00 to 04:00	66.12
11.	16:00 to 17:00	59.29	23.	04:00 to 05:00	69.60
12.	17:00 to 18:00	61.85	24.	05:00 to 06:00	69.06

OVERALL RESULT

Leq	L_{10}	L_{50}	L_{90}	L_{max}	L_{min}	L_{day}	L_{night}	L_{DN}
66.55	72.68	63.59	59.35	80.68	57.25	66.13	63.14	64.64

PERMISSIBLE LIMIT: AMBIENT NOISE STANDARDS as per THE NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000

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

Verified by:

Authorised Signatory

I. KARUPPIAH

"SAVE ENVIRONMENT"

7-4. Soil

.M. EnviroLab Pvt. Ltd.

INTERNATIONAL ENVIRONMENTAL RESEARCH AND DEVELOPMENT CENTRE

Environmental, Mineral & Food Testing Laboratory

Accredited from MoEF-EPA (Govt. of India), NABL, MSME, NSIC, ISO 9001 : 2008, ISO 14001 : 2004 & OHSAS 18001 : 2007

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E-mail: jmenvirolab@hotmail.com • Website : www.jmenvirolab.com

TEST REPORT

Sample Number	: JME/S/RL/10	Report No.	: JME/S/160801010
Name & Address of Unit	: M/s.Rites Limited Rites Bhawan No. 1, Sector-29, Gurgaon (HR)-122001 (Chennai Metro Rail Project Phase-II)		: 5.10 F-05
Sample Description	: SOIL	Party Reference No.	Nil
Sampling Location	: Alwar Thiru Nagar Junction	Reporting Date	: 10/08/2016
Client Representative (Name & Designation)	: Mr.Sanjay Raut (Manager)	Receipt Date	: 01/08/2016
Sample collected by (Name & Designation)	: Party	Sampling Date	: -
Latitude	: --	Sampling Type	: —
Longitude	: --	Sample Quantity	: 2.0 Kg
Sampling & Analysis Protocol	: IS-2720,USDA,Method Manual of Soil Testing in Ind.	Depth of Sampling Packing Status	: : Temp.Sealed

TEST RESULTS

Sl. No.	Parameters	Testing Protocol	Result	Unit
1	pH (at 25 0C)(1:2.5 soil water sus.)	IS : 2720 (P-26,1987)	7.11	-
2	Conductivity(1:2soil water sus.)	IS:14767,2000	0.19	mS/cm
3	Chloride	USDA :1954 Reaffirmed 2010(Page-133)	24.79	mg/kg
4	Available Phosphorus	Method manual of soil Testing in india,(Dept. of Ag.,& Co.Ministry of Ag.Govt.of Ind.)2011,4.6.3(13)	28.24	kg. /hec.
5	Total Zinc as Zn	JMELPL/STOP/02(37)	12.35	mg/kg
6	Manganese as Mn	JMELPL/STOP/02(37)	166.32	mg/kg
7	Total Lead as Pb	JMELPL/STOP/02(37)	9.65	mg/kg
8	Total Copper as Cu	JMELPL/STOP/02(37)	14.82	mg/kg
9	Organic Carbon	IS:2720 (P-22, 1972)	0.73	%
10	Water Soluble Sulphate	USDA :1954 Reaffirmed 2010\	20.12	mg/kg
11	Boron	USDA :1954 Reaffirmed 2010\	1.86	mg/kg
12	Iron	USDA :1954 Reaffirmed 2010\	420.37	mg/kg
13	Nikel	USDA :1954 Reaffirmed 2010\	18.27	mg/kg
14	Bicarbonates	USDA :1954 Reaffirmed 2010\	125.89	mg/kg
15	Calcium	Method manual of soil Testing in india, (Department of Ag.,and Corporation Ministry of Ag. Govt.of I	140.09	mg/kg
16	Magnesium	Method manual of soil Testing in india, (Department of Ag.,and Corporation	27.28	mg/kg

Tested by

Checked by

Authorized Signatory

Note:

1. The test report has been prepared as per requested and test result pertains to the tested sample received.
2. This report is for your satisfaction only and not to be used for any legal purposes.
3. Any discrepancy in the test report or any remarks regarding the test results should be brought to our knowledge within 7 days of the issue of this report.
4. Responsibility on any claim in case of dispute is limited to the invoice raised by the laboratory.
5. The sample will be destroyed after retention time unless otherwise specified.
6. Endorsement of the product tested by the laboratory is neither inferred nor implied.

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INTERNATIONAL ENVIRONMENTAL RESEARCH AND DEVELOPMENT CENTRE
Environmental, Mineral & Food Testing Laboratory
Accredited from MoEF-EPA (Govt. of India), NABL, MSME, NSIC, ISO 9001 : 2008, ISO 14001 : 2004 & OHSAS 18001 : 2007
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TEST REPORT

Sample Number : JME/S/RL/10 Report No. : JME/S/160801010

TEST RESULTS

Sl. No.	Parameters	Testing Protocol	Result	Unit
16		Ministry of Ag. Govt.of I		
17	Sand	USDA :1964 Reaffirmed 2010\	34.93	%
18	Silt	USDA :1954 Reaffirmed 2010\	36.88	%
19	Clay	USDA :1954 Reaffirmed 2010\	28.19	%
20	Sodium	USDA :1954 Reaffirmed 2010\	56.45	mg/kg
21	Potassium	Method manual of soil Testing in india, (Department of Ag.,and Corporation Ministry of Ag. Govt.of I	70.18	kg. /hec.
22	Sulphur	USDA :1954 Reaffirmed 2010\	29.16	kg. /hec.
23	Organic Matter	IS:2720 (P-22, 1972) 2001	1.26	%
24	Orthophosphate	USDA :1954 Reaffirmed 2010\	70.65	mg/kg
25	Carbonates	USDA :1954 Reaffirmed 2010\	2.99	mg/kg
25	Arsenic	JMELPL/STOP/02(37)	BDL(DL-0.05mg/kg)	mg/kg
27	Mercury	USDA :1954 Reaffirmed 2010\	BDL(DL-0.1mg/kg)	mg/kg
28	Cadmium as Cd	JMELPL/STOP/02(37)	1.24	mg/kg
29	Molybdenum	USDA :1954 Reaffirmed 2010\	0.60	mg/kg
30	Available Nitrogen	IS:14684, 1999	199.97	kg. /hec.

End of Report

Tested by Checked by Authorized Signatory

Note:

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Approved from MoEF-EPA, Haryana State Pollution Control Board & Certified-ISO 9001:2008, ISO 14001:2015, OHSAS 18001:2007

TEST REPORT

Sample Number	: JME/RITES/S/02	Report No.	: JME/S/180516002
Name & Address of Unit	: M/s.RITES Limited RITES Bhawan No.-1, Sector-29, Gurgaon-122001 (HR)		: 5.10 F-05
Sample Description	: SOIL	Party Reference No.	: Nil
Sampling Location	: Polur jn	Reporting Date	: 23/05/2018
Client Representative (Name & Designation)	: Mr. Manish Indurkar (Assistant Manager/UE)	Receipt Date	: 16/05/2018
Sample collected by (Name & Designation)	: Party	Sampling Date	: -
		Sampling Type	: --
Latitude	: ----	Sample Quantity	: 2.0 kg.
Longitude	: ----	Depth of Sampling	: --
Sampling & Analysis Protocol	: IS-2720,USDA,Method Manual of Soil Testing in Ind.	Packing Status	: Temp. Seald Packed

TEST RESULTS

Sl. No.	Parameters	Testing Protocol	Result	Unit
1	pH (at 25°C)(1:2.5 soil water sus.)	IS : 2720 (P-26,1987)	8.05	-
2	Conductivity(1:2soil water sus.)	IS:14767,2000	0.24	mS/cm
3	Chloride	USDA :1954 Reaffirmed 2010(Page-133)	359.93	mg/kg
4	Available Phosphorus	Method manual of soil Testing in india,(Dept. of Ag.,& Co.Ministry of Ag.Govt.of Ind.)2011,4.6.3(13)	24.60	kg. /hec.
5	Total Zinc as Zn	JMELPL/STOP/02(37)	69.14	mg/kg
6	Manganese as Mn	JMELPL/STOP/02(37)	141.38	mg/kg
7	Total Lead as Pb	JMELPL/STOP/02(37)	BDL(DL 5.0)	mg/kg
8	Total Copper as Cu	JMELPL/STOP/02(37)	14.80	mg/kg
	Organic Carbon	IS:2720 (P-22, 1972)	0.35	%
10	Water Soluble Sulphate	USDA :1954 Reaffirmed 2010\	40.16	mg/kg
11	Boron	USDA :1954 Reaffirmed 2010\	1.66	mg/kg
12	Iron	USDA :1954 Reaffirmed 2010\	1299.51	mg/kg
13	Nikel	USDA :1954 Reaffirmed 2010\	BDL(DL 5.0)	mg/kg
14	Bicarbonates	USDA :1954 Reaffirmed 2010\	168.44	mg/kg
15	Calcium	Method manual of soil Testing in india, (Department of Ag.,and Corporation Ministry of Ag. Govt.of I	480.96	mg/kg
16	Magnesium	Method manual of soil Testing in india, (Department of Ag.,and Corporation	41.34	mg/kg

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Authorized Signatory

25 years of success

J M ENVIROLAB PVT LTD

Approved from MoEF-EPA, Haryana State Pollution Control Board & Certified-ISO 9001:2008, ISO 14001:2015, OHSAS 18001:2007

TEST REPORT

Sample Number : JME/RITES/S/02 Report No. : JME/S/180516002

TEST RESULTS

Sl. No.	Parameters	Testing Protocol	Result	Unit
16		Ministry of Ag. Govt.of I		
17	Sand	USDA :1954 Reaffirmed 2010\	32.97	%
18	Silt	USDA :1954 Reaffirmed 2010\	59.34	%
19	Clay	USDA :1954 Reaffirmed 2010\	7.69	%
20	Sodium	USDA :1954 Reaffirmed 2010\	129.33	mg/kg
21	Potassium	Method manual of soil Testing in india, (Department of Ag.,and Corporation Ministry of Ag. Govt.of I	271.60	kg /hec
22	Sulphur	USDA :1954 Reaffirmed 2010\	42.55	kg /hec
23	Organic Matter	IS:2720 (P-22, 1972) 2001	0.60	%
24	Orthophosphate	USDA :1954 Reaffirmed 2010\	6.80	mg/kg
25	Carbonates	USDA :1954 Reaffirmed 2010\	10.20	mg/kg
26	Arsenic	JMELP/STOP/02(37)	BDL(DL 0.5)	mg/kg
27	Mercury	USDA :1954 Reaffirmed 2010\	BDL(DL 0.5)	mg/kg
28	Cadmium as Cd	JMELP/STOP/02(37)	BDL(DL 5.0)	mg/kg
29	Molybdenum	USDA :1954 Reaffirmed 2010\	BDL(DL 5.0)	mg/kg
30	Available Nitrogen	IS:14684, 1999	172.50	kg /hec

End of Report

Tested by Checked by Authorized Signatory

J.M. EnviroLab Pvt. Ltd.

INTERNATIONAL ENVIRONMENTAL RESEARCH AND DEVELOPMENT CENTRE

Environmental, Mineral & Food Testing Laboratory

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TEST REPORT

Sample Number	: JME/S/RL/09	Report No.	: JME/S/160801009
Name & Address of Unit	: M/s.Rites Limited Rites Bhawan No. 1, Sector-29, Gurgaon (HR)-122001 (Chennai Metro Rail Project Phase-II)		: 5.10 F-05
Sample Description	: SOIL	Party Reference No.	Nil
Sampling Location	: MIOT Hospital	Reporting Date	: 10/08/2016
Client Representative (Name & Designation)	: Mr.Sanjay Raut (Manager)	Receipt Date	: 01/08/2016
Sample collected by (Name & Designation)	: Party	Sampling Date	: -
Latitude	: --	Sampling Type	: ---
Longitude	: --	Sample Quantity	: 2.0 Kg
Sampling & Analysis Protocol	: IS-2720,USDA,Method Manual of Soil Testing in Ind.	Depth of Sampling	:
		Packing Status	: Temp.Sealed

TEST RESULTS

Sl. No	Parameters	Testing Protocol	Result	Unit
1	pH (at 25 0C)(1:2.5 soil water sus.)	IS : 2720 (P-26,1987)	7.75	-
2	Conductivity(1:2soil water sus.)	IS:14767,2000	0.22	mS/cm
3	Chloride	USDA :1954 Reaffirmed 2010(Page-133)	33.37	mg/kg
4	Available Phosphorus	Method manual of soil Testing in india,(Dept. of Ag.,& Co.Ministry of Ag.Govt.of Ind.)2011,4.6.3(13)	25.83	kg. /hec.
5	Total Zinc as Zn	JMELPL/STOP/02(37)	12.37	mg/kg
6	Manganese as Mn	JMELPL/STOP/02(37)	190.32	mg/kg
7	Total Lead as Pb	JMELPL/STOP/02(37)	10.77	mg/kg
8	Total Copper as Cu	JMELPL/STOP/02(37)	19.45	mg/kg
9	Organic Carbon	IS:2720 (P-22, 1972)	0.63	%
10	Water Soluble Sulphate	USDA :1954 Reaffirmed 2010\	16.99	mg/kg
11	Boron	USDA :1954 Reaffirmed 2010\	2.27	mg/kg
12	Iron	USDA :1954 Reaffirmed 2010\	448.5	mg/kg
13	Nikel	USDA :1954 Reaffirmed 2010\	20.18	mg/kg
14	Bicarbonates	USDA :1954 Reaffirmed 2010\	136.62	mg/kg
15	Calcium	Method manual of soil Testing in India, (Department of Ag.,and Corporation Ministry of Ag. Govt.of I	160.24	mg/kg
16	Magnesium	Method manual of soil Testing in India, (Department of Ag.,and Corporation	27.98	mg/kg

Tested by

Checked by

Authorized Signatory

Note:

1. This test report has been prepared at your request and test result is applicable to the tested sample received.
2. This report is for your reference only and not to be used for any legal purposes.
3. Any discrepancy in the test report or any remarks regarding the test results shall be brought to our knowledge within 7 days of the issue of this report.
4. Responsibility in any case in case of dispute is limited to the invoice raised by the laboratory.
5. The samples will be destroyed after retention time unless otherwise specified.
6. Endorsement of the product tested by the laboratory is neither inferred nor implied.
7. All disputes are subject to Gurgaon jurisdiction only.

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TEST REPORT

Sample Number : JME/S/RL/09 Report No. : JME/S/160801009

TEST RESULTS

Sl. No.	Parameters	Testing Protocol	Result	Unit
16		Ministry of Ag. Govt.of I		
17	Sand	USDA :1964 Reaffirmed 2010\	31.97	%
18	Silt	USDA :1964 Reaffirmed 2010\	39.05	%
19	Clay	USDA :1964 Reaffirmed 2010\	28.98	%
20	Sodium	USDA :1964 Reaffirmed 2010\	45.55	mg/kg
21	Potassium	Method manual of soil Testing in india, (Department of Ag.,and Corporation Ministry of Ag. Govt.of I	78.03	kg. /hec.
22	Sulphur	USDA :1954 Reaffirmed 2010\	26.78	kg. /hec.
23	Organic Matter	IS:2720 (P-22, 1972) 2001	1.08	%
24	Orthophosphate	USDA :1954 Reaffirmed 2010\	67.08	mg/kg
25	Carbonates	USDA :1954 Reaffirmed 2010\	5.01	mg/kg
26	Arsenic	JMELPL/STOP/02(37)	BDL(DL-0.05mg/kg)	mg/kg
27	Mercury	USDA :1964 Reaffirmed 2010\	BDL(DL-0.1mg/kg)	mg/kg
28	Cadmium as Cd	JMELPL/STOP/02(37)	1.66	mg/kg
29	Molybdenum	USDA :1964 Reaffirmed 2010\	0.82	mg/kg
30	Available Nitrogen	IS:14684, 1999	305.38	kg. /hec.

End of Report

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Note:

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TEST REPORT

Accredited by NABL & NABET, Certified ISO 9001:2015 & ISO 14001:2015

Report No	: PCEI/TR-Soil-4409	**Report Date**	: 16.12.2019
ULR No.	: ULR-TC446190003422P		
Issued to	: **M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: PCEI/SOP/SOIL/01		
Sampled by	: Laboratory		
Sample Collected Date	: 11.12.2019	**Sample Reference No**	: PCEI/Soil-N322-12-19
Sample Description	: **Soil**	**Sample Received On**	: 12.12.2019
Qty of Sample Received	: 2Kg	**Test Commenced On**	: 12.12.2019
Sample Condition	: Fit for Analysis	**Test Completed On**	: 16.12.2019
Sampling Location	: **Madipakkam Koot Road Junction**		

S.No	Parameters	Units	Test Method	Results
1	pH @ 25°C	-	IS 2720 (Part 26) 1987 (RA 2002)	5.34
2	Electrical Conductivity @ 25°C	µmhos/cm	IS 14767:2000 (RA 2016)	35
3	Available Nitrogen (as N)	%	IS 5194 : 1969 (RA 2010)	0.31
4	Ortho Phosphate	mg/kg	IS: 10158:1982 (Reaff. 2003)	214
5	Potassium (as K)	mg/kg	EPA 3050 B & 7610	98
6	Boron	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	14
7	Available Nitrogen (as N)	Kg/hec	IS: 10158:1982 (Reaff. 2003)	5813
8	Manganese (as Mn)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	16.2
9	Iron (as Fe)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	318
10	Zinc (as Zn)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	32.2
11	Copper (as Cu)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	24.3
12	Organic Matter	%	IS 2720 (Part 22) 1972 (RA 2006)	1.45
13	Lead (as Pb)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)

Verified By

Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

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TEST REPORT

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Report No	: PCEI/TR-Soil-4409	Report Date	: 16.12.2019

S.No	Parameters	Units	Test Method	Results
14	Nickel (as Ni)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)
15	Sodium (as Na)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	2154
16	Bicarbonates as HCO_3	mg/kg	PCEI/SOP/S/013	16
17	Carbonates as CO3	mg/kg	PCEI/SOP/S/013	12.6
18	Chlorides	mg/kg	PCEI/SOP/S/006	18.3
19	Mercury	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)
20	Molybdenum	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)
21	Magnesium	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	38.6
22	Calcium	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	7.39
23	Organic carbon	%	IS 2720 (Part 22) 1972	0.84
24	Sulphates	mg/kg	IS 2720 (Part 27) 1977	82
25	Sulphur (S)	mg/kg	PCEI/SOP/S/045	27.4
26	Arsenic (as As)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)
27	Cadmium (as Cd)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)
Texture				
28	Sand	%	Manual for Soil Analysis	51.7
29	Clay	%	Manual for Soil Analysis	22
30	Silt	%	Manual for Soil Analysis	26.3

..... End of Report .....

Verified By

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TEST REPORT

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Report No	: PCEI/TR-Soil-4410	**Report Date**	: 16.12.2019
ULR No.	: ULR-TC744619000342JP		
Issued to	: **M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: PCEI/SOP/SOIL/01		
Sampled by	: Laboratory		
Sample Collected Date	: 11.12.2019	**Sample Reference No**	: PCEI/Soil-N323-12-19
Sample Description	: **Soil**	**Sample Received On**	: 12.12.2019
Qty of Sample Received	: 2Kg	**Test Commenced On**	: 12.12.2019
Sample Condition	: Fit for Analysis	**Test Completed On**	: 16.12.2019
Sampling Location	: **Vellakal Bus Stop**		

S.No	Parameters	Units	Test Method	Results
1	pH @ 25°C	-	IS 2720 (Part 26) 1987 (RA 2002)	5.94
2	Electrical Conductivity @ 25°C	µmhos/cm	IS 14767:2000 (RA 2016)	61
3	Available Nitrogen (as N)	%	IS 5194 :1969 (RA 2010)	0.51
4	Ortho Phosphate	mg/kg	IS: 10158:1982 (Reaff. 2003)	12.3
5	Potassium (as K)	mg/kg	EPA 3050 B & 7610	148
6	Boron	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	24
7	Available Nitrogen (as N)	Kg/hac	IS: 10158:1982 (Reaff. 2003)	9563
8	Manganese (as Mn)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	14.3
9	Iron (as Fe)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	184
10	Zinc (as Zn)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	16.2
11	Copper (as Cu)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	14.3
12	Organic Matter	%	IS 2720 (Part 22) 1972 (RA 2006)	1.84
13	Lead (as Pb)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)

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Report No	: PCEI/TR-Soil-4410	**Report Date**	: 16.12.2019

S.No	Parameters	Units	Test Method	Results
14	Nickel (as Ni)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)
15	Sodium (as Na)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	1436
16	Bicarbonates as HCO_3	mg/kg	PCEI/SOP/S/013	32
17	Carbonates as CO3	mg/kg	PCEI/SOP/S/013	14
18	Chlorides	mg/kg	PCEI/SOP/S/006	68.3
19	Mercury	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)
20	Molybdenum	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)
21	Magnesium	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	44.3
22	Calcium	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	27.4
23	Organic carbon	%	IS 2720 (Part 22) 1972	0.86
24	Sulphates	mg/kg	IS 2720 (Part 27) 1977	16.3
25	Sulphur (S)	mg/kg	PCEI/SOP/S/045	5.46
26	Arsenic (as As)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)
27	Cadmium (as Cd)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)
Texture				
28	Sand	%	Manual for Soil Analysis	44.4
29	Clay	%	Manual for Soil Analysis	23
30	Silt	%	Manual for Soil Analysis	32.6

..... End of Report .....

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TEST REPORT

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Report No	: PCEI/TR-Soil-4400	**Report Date**	: 16.12.2019
ULR No.	: ULR-TC744619000342IP		
Issued to	: **M/s Chennai Metro Rail Limited** CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107		
Sampling Method	: PCEI/SOP/SOIL/01		
Sampled by	: Laboratory		
Sample Collected Date	: 11.12.2019	**Sample Reference No**	: PCEI/Soil-N321-12-19
Sample Description	: **Soil**	**Sample Received On**	: 12.12.2019
Qty of Sample Received	: 2Kg	**Test Commenced On**	: 12.12.2019
Sample Condition	: Fit for Analysis	**Test Completed On**	: 16.12.2019
Sampling Location	: **Near Adambakkam MRTS**		

S.No	Parameters	Units	Test Method	Results
1	pH @ 25°C	-	IS 2720 (Part 26) 1987 (RA 2002)	6.15
2	Electrical Conductivity @ 25°C	µmhos/cm	IS 14767:2000 (RA 2016)	102
3	Available Nitrogen (as N)	%	IS: 10158:1982 (Reaff. 2003)	0.28
4	Ortho Phosphate	mg/kg	IS: 10158:1982 (Reaff. 2003)	794
5	Potassium (as K)	mg/kg	EPA 3050 B & 7610	45.6
6	Available Nitrogen (as N)	Kg/hec	IS: 10158:1982 (Reaff. 2003)	5250
7	Boron	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	0.039
8	Manganese (as Mn)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	15
9	Iron (as Fe)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	245
10	Zinc (as Zn)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	14.2
11	Copper (as Cu)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	22.3
12	Organic Matter	%	IS 2720 (Part 22) 1972 (RA 2006)	1.6
13	Lead (as Pb)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)

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TEST REPORT

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Report No	: PCEI/TR-Soil-4408	Report Date	: 16.12.2019

S.No	Parameters	Units	Test Method	Results
14	Nickel (as Ni)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)
15	Sodium (as Na)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	1458
16	Bicarbonates as HCO_3	mg/kg	PCEI/SOP/S/013	24.3
17	Carbonates as CO3	mg/kg	PCEI/SOP/S/013	18.6
18	Chlorides	mg/kg	PCEI/SOP/S/006	42.6
19	Mercury	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)
20	Molybdenum	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)
21	Magnesium	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	24.6
22	Calcium	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	17.1
23	Organic carbon	%	IS 2720 (Part 22) 1972	0.92
24	Sulphates	mg/kg	IS 2720 (Part 27) 1977	145
25	Sulphur (S)	mg/kg	PCEI/SOP/S/045	48.4
26	Arsenic (as As)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)
27	Cadmium (as Cd)	mg/kg	USEPA 3050 B: 1996 USEPA 6020B: 1996	BDL(DL:0.1)
Texture				
28	Sand	%	Manual for Soil Analysis	53.5
29	Clay	%	Manual for Soil Analysis	18
30	Silt	%	Manual for Soil Analysis	28.5

..... End of Report .....

Verified By

Authorised Signatory
Name: Krishnan G
Designation: Technical Manager

JM

J.M. EnviroLab Pvt. Ltd.

INTERNATIONAL ENVIRONMENTAL RESEARCH AND DEVELOPMENT CENTRE

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TEST REPORT

Sample Number	: JME/S/RL/12	Report No.	: JME/S/160801012
Name & Address of Unit	: M/s.Rites Limited Rites Bhawan No. 1, Sector-29, Gurgaon (HR)-122001 (Chennai Metro Rail Project Phase-II)		: 5.10 F-05
Sample Description	: SOIL	Party Reference No.	Nil
Sampling Location	: Medavakkam Junction	Reporting Date	: 10/08/2016
Client Representative (Name & Designation)	: Mr.Sanjay Raut (Manager)	Receipt Date	: 01/08/2016
Sample collected by (Name & Designation)	: Body	Sampling Date	: -
		Sampling Type	: ---
		Sample Quantity	: 2.0 Kg
Latitude	: --	Depth of Sampling	:
Longitude	: --	Packing Status	: Temp.Sealed
Sampling & Analysis Protocol	: IS-2720,USDA,Method Manual of Soil Testing in Ind.		

TEST RESULTS

Sl. No.	Parameters	Testing Protocol	Result	Unit
1	pH (at 25 0C)(1:2.5 soil water sus.)	IS : 2720 (P-26,1987)	7.86	-
2	Conductivity(1:2soil water sus.)	IS:14767,2000	0.25	mS/cm
3	Chloride	USDA :1954 Reaffirmed 2010(Page-133)	19.11	mg/kg
4	Available Phosphorus	Method manual of soil Testing in india,(Dept. of Ag.,& Co.Ministry of Ag.Govt.of Ind.)2011,4.6.3(13)	23.97	kg. /hec.
5	Total Zinc as Zn	JMELPL/STOP/02(37)	13.20	mg/kg
6	Manganese as Mn	JMELPL/STOP/02(37)	118.37	mg/kg
7	Total Lead as Pb	JMELPL/STOP/02(37)	11.40	mg/kg
8	Total Copper as Cu	JMELPL/STOP/02(37)	16.23	mg/kg
9	Organic Carbon	IS:2720 (P-22, 1972)	0.59	%
10	Water Soluble Sulphate	USDA :1954 Reaffirmed 2010\	22.53	mg/kg
11	Boron	USDA :1954 Reaffirmed 2010\	1.76	mg/kg
12	Iron	USDA :1954 Reaffirmed 2010\	428.23	mg/kg
13	Nikel	USDA :1954 Reaffirmed 2010\	18.21	mg/kg
14	Bicarbonates	USDA :1954 Reaffirmed 2010\	126.35	mg/kg
15	Calcium	Method manual of soil Testing in india, (Department of Ag.,and Corporation Ministry of Ag. Govt.of I	86.82	mg/kg
16	Magnesium	Method manual of soil Testing in india, (Department of Ag.,and Corporation	22.36	mg/kg

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J.M. ENVIROLAB PVT. LTD. INDIA — Authorised Signatory

Note:

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TEST REPORT

Sample Number : JME/S/RL/12

Report No. : JME/S/160801012

TEST RESULTS

Sl. No.	Parameters	Testing Protocol	Result	Unit
16		Ministry of Ag. Govt.of I		
17	Sand	USDA :1954 Reaffirmed 2010\	35.17	%
18	Silt	USDA :1954 Reaffirmed 2010\	39.06	%
19	Clay	USDA :1954 Reaffirmed 2010\	26.77	%
20	Sodium	USDA :1954 Reaffirmed 2010\	47.45	mg/kg
21	Potassium	Method manual of soil Testing in India, (Department of Ag.,and Corporation Ministry of Ag. Govt.of I	98.53	kg. /hec.
22	Sulphur	USDA :1954 Reaffirmed 2010\	26.27	kg. /hec.
23	Organic Matter	IS:2720 (P-22, 1972) 2001	1.03	%
24	Orthophosphate	USDA :1954 Reaffirmed 2010\	73.91	mg/kg
25	Carbonates	USDA :1954 Reaffirmed 2010\	5.03	mg/kg
26	Arsenic	JMELPL/STOP/02(37)	BDL(DL-0.05mg/kg)	mg/kg
27	Mercury	USDA :1954 Reaffirmed 2010\	BDL(DL-0.1mg/kg)	mg/kg
28	Cadmium as Cd	JMELPL/STOP/02(37)	1.31	mg/kg
29	Molybdenum	USDA :1954 Reaffirmed 2010\	0.69	mg/kg
30	Available Nitrogen	IS:14684, 1999	268.66	kg. /hec.

End of Report

Tested by

Checked by

J.M. ENVIROLAB PVT. LTD. Authorised Signatory

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Note:

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TEST REPORT

Sample Number	: JME/S/RL/13	Report No.	: JME/S/160801013
Name & Address of Unit	: M/s.Rites Limited Rites Bhawan No. 1, Sector-29, Gurgaon (HR)-122001 (Chennai Metro Rail Project Phase-II)		: 5.10 F-05
Sample Description	: SOIL	Party Reference No:	Nil
Sampling Location	: Near Global Hospital	Reporting Date	: 10/08/2016
Client Representative (Name & Designation)	: Mr.Sanjay Raut (Manager)	Receipt Date	: 01/08/2016
Sample collected by (Name & Designation)	: Party	Sampling Date	: -
Latitude	: --	Sampling Type	: ---
Longitude	: --	Sample Quantity	: 2.0 Kg
		Depth of Sampling	:
Sampling & Analysis Protocol	: IS-2720,USDA,Method Manual of Soil Testing in Ind.	Packing Status	: Temp.Sealed

TEST RESULTS

Sl. No.	Parameters	Testing Protocol	Result	Unit
1	pH (at 25 0C)(1:2.5 soil water sus.)	IS : 2720 (P-26,1987)	7.28	-
2	Conductivity(1:2soil water sus.)	IS:14767,2000	0.17	mS/cm
3	Chloride	USDA :1954 Reaffirmed 2010(Page-133)	47.67	mg/kg
4	Available Phosphorus	Method manual of soil Testing in india.(Dept. of Ag.,& Co.Ministry of Ag.Govt.of Ind.)2011,4.6.3(13)	22.16	kg. /hec.
5	Total Zinc as Zn	JMELPL/STOP/02(37)	14.36	mg/kg
6	Manganese as Mn	JMELPL/STOP/02(37)	197.08	mg/kg
7	Total Lead as Pb	JMELPL/STOP/02(37)	8.78	mg/kg
8	Total Copper as Cu	JMELPL/STOP/02(37)	16.88	mg/kg
9	Organic Carbon	IS:2720 (P-22, 1972)	0.66	%
10	Water Soluble Sulphate	USDA :1954 Reaffirmed 2010\	27.84	mg/kg
11	Boron	USDA :1954 Reaffirmed 2010\	1.33	mg/kg
12	Iron	USDA :1954 Reaffirmed 2010\	455.64	mg/kg
13	Nikel	USDA :1954 Reaffirmed 2010\	20.02	mg/kg
14	Bicarbonates	USDA :1954 Reaffirmed 2010\	126.36	mg/kg
15	Calcium	Method manual of soil Testing in india, (Department of Ag.,and Corporation Ministry of Ag. Govt.of I	76.28	mg/kg
16	Magnesium	Method manual of soil Testing in india, (Department of Ag.,and Corporation	20.36	mg/kg

Tested by Checked by Authorized Signatory

Note:

J.M. EnviroLab Pvt. Ltd. INTERNATIONAL ENVIRONMENTAL RESEARCH AND DEVELOPMENT CENTRE

Environmental, Mineral & Food Testing Laboratory

Accredited from MoEF-EPA (Govt. of India), NABL, MSME, NSIC, ISO 9001 : 2008, ISO 14001 : 2004 & OHSAS 18001 : 2007

SCO-16, Sector-10A, Gurgaon-122 001 (Haryana) INDIA • TEL.: +91-124-4873400 • FAX: +91-124-4141029

E-mail: jmenvirolab@hotmail.com • Website : www.jmenvirolab.com

TEST REPORT

Sample Number : JME/S/RL/13 Report No. :JME/S/160801013

TEST RESULTS

Sl. No.	Parameters	Testing Protocol	Result	Unit
16		Ministry of Ag. Govt.of I		
17	Sand	USDA :1954 Reaffirmed 2010\	35.78	%
18	Silt	USDA :1954 Reaffirmed 2010\	37.66	%
19	Clay	USDA :1954 Reaffirmed 2010\	28.56	%
20	Sodium	USDA :1954 Reaffirmed 2010\	42.32	mg/kg
21	Potassium	Method manual of soil Testing in India, (Department of Ag.,and Corporation Ministry of Ag. Govt.of I	92.76	kg. /hec.
22	Sulphur	USDA :1954 Reaffirmed 2010\	19.27	kg. /hec.
23	Organic Matter	IS:2720 (P-22, 1972) 2001	1.05	%
24	Orthophosphate	USDA :1954 Reaffirmed 2010\	76.20	mg/kg
25	Carbonates	USDA :1954 Reaffirmed 2010\	3.88	mg/kg
26	Arsenic	JMELPL/STOP/02(37)	BDL(DL-0.05mg/kg)	mg/kg
27	Mercury	USDA :1954 Reaffirmed 2010\	BDL(DL-0.1mg/kg)	mg/kg
28	Cadmium as Cd	JMELPL/STOP/02(37)	1.36	mg/kg
29	Molybdenum	USDA :1954 Reaffirmed 2010\	0.63	mg/kg
30	Available Nitrogen	IS:14684, 1999	264.53	kg. /hec.

End of Report

Tested by

Checked by

J.M. ENVIROLAB PVT. LTD. Authorised Signatory

Authorized Signatory

Note:

1. The above report has been prepared on your request and the results pertain to the tested sample received.
2. This report is for your reference only and not to be used for any legal purposes.
3. Any discrepancy in the test report or any remarks regarding the test results shall be brought to our knowledge within 7 days of the issue of this report.
4. Total liability under any circumstances in case of dispute is limited to the service rendered by the laboratory.
5. The sample will be destroyed after stipulated time unless otherwise specified.
6. Reproduction of the product tested by the laboratory for commercial advertisement is prohibited.
7. All disputes are subject to exclusive jurisdiction of Jaipur court only.

Annexure 8. COVID-19 SOP

Chennai Metro Rail Limited

CMRL - Standard Operating Procedure (SOP)

for metro operation after restoration of metro services

1. **Preparatory Works for Commencing Operation:**

(i) It shall be ensured that all the systems are in safe and healthy condition before resumption of revenue service.

(ii) Train Operation involves systems pertaining to Electrical, S&T, Civil, Track, Rolling Stock, Traction etc. therefore its safe functionality shall be ensured before start of passenger services.

(iii) Metro personnel shall be given proper counselling so that they themselves gain confidence and handle the situation in a proper manner.

(iv) Advance planning for mobilizing staff, equipment and materials for cleaning and maintenance, pre-checks of essential equipment at stations & in trains shall be ensured.

(v) Advisories to public through electronic/print/social media to avoid unnecessary travel to manage the crowd inside stations and trains in order to maintain social distancing shall be issued be issued regularly. Necessary Do's and Don'ts shall be displayed at metro Stations/other prominent locations.

2. Train Services:

(i) Trial run shall be done on all lines before introduction of revenue services.

(ii) CMRL shall start revenue service of Line-1 from 7-9-2020 and Line -2 from 9-9-2020 with operational hours from 8:00 to 20:00 hrs and headway of 10 min. during peak hours & 15 min. during Non-peak. The services shall be reviewed based on Public response from time to time.

(iii) Number of passengers shall be regulated at the entry of the stations itself to ensure social distancing inside the trains and at stations.

(iv) Social distancing shall also be monitored through CCTV.

(v) During boarding and travel, all passengers will have to observe social distancing.

(vi) Suitable marking like 'X' shall be put on alternate seats so that passengers sit on alternate seats to ensure social distancing.

(vii) Passengers shall be advised to sit on alternate seats or stand keeping distance of 6 feet to maintain social distancing through announcements at stations, trains and awareness through social media, posters etc.

(viii) The dwelling time of trains shall be increased to 50 seconds, so that passengers have sufficient time to board and alight following social distancing. This will avoid unnecessary crowding during entry/exit into/from the train. Dwelling time may be

reviewed and suitably altered depending upon the commuter footfall. Additional Metro trains may be introduced to clear the extra rush of the commuters.

(ix) Intake of fresh air in air conditioning system of the coaches shall be increased to the extent possible so that more fresh air is available to passengers. Temperature inside the train shall be maintained in the range of 24-30 degree Celsius.

(x) The trains shall not stop at the stations falling in containment zone and such stations shall not be opened for public.

(xi) Some of the stations may be skipped to ensure proper social distancing.

(xii) Train doors shall remain open for minimum 2 minutes at terminal stations to let fresh air infuse in the train.

3. Stations:

(i) Proper functionality of the systems like lifts, escalators, AFC, Signalling and Communication etc. prior to operation for public shall be examined and checked. Proper cleanliness and hygiene shall be maintained inside the stations.

(ii) Wearing of face mask/cover shall be mandatory for all commuters during entry into the stations/trains and during the entire journey.

(iii) Use of' Aarogya Setu App' shall be encouraged at the time of entry into the station.

(iv) Social distancing shall be followed at stations by controlling the crowd at station entry points.

(v) All passengers shall be thermally screened by Security/Metro officials.

(vi) Only two gates on either side of the road shall be kept open for entry/exit. However, other gates shall remain functional for exit or entry during contingencies.

(vii) Sanitizers will be provided to all passengers at the entry points.

(Viii) Use of lifts shall be permitted only for aged and physically handicapped persons. In this regard, proper signage shall be pasted and regular sanitization of these lifts be ensured. Instructions at all lifts shall be displayed for limiting 2-3 persons per lift, depending upon the size of the lift. Foot operated switches have also been retrofitted in a few stations and such measures shall be taken in all stations.

(ix) Passengers may be advised to stand on alternate steps on escalators to maintain social distance.

4. Ticketing

(i) Cashless transactions to be encouraged to avoid spreading of COVID 19 through currency notes/coins. Use of Smart cards shall be encouraged. Smart card recharge may be done through internet or other cashless methods. Digitized transactions through available modes to be encouraged.

(ii) QR code based mobile ticketing shall be introduced to encourage contactless journey.

(iii) Tokens may be issued for single journey tickets based on demand, however such usage shall be discouraged and proper measures to sanitize before and after usage.

5. Crowd Control:

(i) Whenever excess passengers are observed in concourse or platform area, entry of the passengers at the gate may be restricted.

(ii) The areas of concentration where crowding can take place are as under:

Entry gates & Frisking area near gates

Ticket Counters, Customer Care

Ticketing Vending Machines (TVM)

AFC Gates at entry and Exit.

Lifts, Escalators & Platforms

(iii) Strip markers or any other markers on floor at interval of 6 feet to maintain social distancing at above locations shall be provided.

(iv) Additional supervisory staff shall be deployed at all stations to maintain social distancing by the passengers at crowding points. It may also be regularly monitored through OCC & Security control.

6. Cleanliness and Sanitisation:

a) Stations:

(i) All kinds of equipment and working areas, which are frequented by management/ security personnel/ commuters in Metro premises like concourse, passages, platforms, stairs, glass work, Auto Fare collection (AFC), Lifts, Escalators, Hand Rails, holding areas, Sitting areas, Shopping areas etc. shall be disinfected / sanitized and logs/ records shall be maintained accordingly.

(ii) Public toilets shall be given special attention. These shall be cleaned, disinfected more frequently as per requirement.

(iii) All human contact areas e.g. Lift buttons, Escalator hand rails, customer handling points to be disinfected frequently at stations preferably every 4 hours or earlier as per requirement.

b) Trains:

(iv) Metro trains shall be cleaned/disinfected thoroughly during non-revenue hours at depots before putting them into passenger services.

7. Heating, Ventilation and Air Conditioning (HV AC) system:

Central Public Works Department (CPWD) vide Office Memorandum No. CE CSO(E)/COVID-19/2020/028 Dated 13.05.2020 has issued "Guidelines for Running of Air Circulation, Air Cooling and Air Conditioning Equipment's during COVID-19" for guidance of field units of CPWD

Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE) has also issued guidelines for Air Conditioning and Ventilation during COVID-19. These guidelines shall strictly be adhered to.

8. Feeder Services, Parking and Shops at stations:

(i) For maintaining social distancing, adequate number of metro feeder services/ e-rickshaws for passengers shall be deployed as per local conditions and guidelines.

(ii) All the Parking spaces shall be opened.

(iii) Shops/Kiosks/Food Points at stations may be opened.

9. Safety and Security:

(i) The aspect of safety and security of Metro operation shall be ensured in accordance with the laid down direction of Government of India and as per Disaster Management Act 2005.

(ii) Under all conditions including for operation and security related issues, social distancing shall be ensured. Pre-recorded advisories to commuter to adhere to the norms of social distancing while boarding and travelling in Metro shall be played at appropriate places.

(iii) Proper PPE kit and sanitisers shall be provided to employee's/ security personnel, who are likely to be in proximate contact with commuters and for longer duration.

(iv) Availability of liquid soaps in washrooms shall be ensured

(v) Staff shall be sensitized to maintain social distancing at all times especially in crew controls, OCC and SCR

(vi) Detailed instructions containing Dos and Don'ts shall be prepared and displayed at prominent work places for educating the staff

(vii) Considering the potential of Corona to spread quickly, security personnel/ private guards Shall resort to contactless frisking of commuters.

(viii) There shall be a Q manager mechanism both at the entry and exit gates. Further, it shall be ensured that passengers should not loiter in metro premises especially between entry gates.

(ix) The security deployed at the Metro stations shall remain in touch and suitably liaise with State Police to supplement the existing security network on the emerging law and order situation.

10. Attention to suspected COVID-19 passengers

Only asymptomatic passengers shall be allowed to enter into the stations. Symptomatic passengers or those having high temperature shall not be allowed to use metro and after recording his/her contact number name and address, he/she shall be directed to report to nearest medical Centre. The details of such persons shall be communicated to local administrations also.

11. Information, Education and Communication (IEC)

(i) There shall be a detailed communication plan prior to commencing operation of services duly indicating measures being taken towards cleanliness and hygiene, screening of passengers for detecting COVID-19 symptoms, social distancing, mandatory wearing of face mask/cover, use of Arogya Setu App, supply of sanitisers to commuters at the entry of stations, Do's and Don'ts, train timing, dwelling time at stations, stopping stations, entry/exit gates to be opened etc. in English/Hindi/Local languages and circulate through Information, Education and Communication (IEC) campaign for their staff and passengers using electronic/print/social media, posters, banners, website etc.

(ii) Wide publicity shall be given suggesting passengers to carry minimum possible luggage and avoid metallic items etc.

(iii) As a part of awareness campaign, management may also formulate a mechanism of pre-recorded advisories to commuter to adhere to the norms of social distancing while boarding and travelling in Metro shall be evolved. Regular announcement in the trains and at stations shall also be made for awareness of passengers.

Annexure 9. Stakeholder Engagement Minutes

9-1. PWD

29.10.2020

Minutes of the Meeting in the Chamber of PWD

Sub: Chennai Metro Rail Ltd., - Phase II project – Elevated Corridor C-5 crossing Adyar river and Adambakkam lake.

Ref: 1. CMRL/CON/CGM(A&CM)/P2C5/P6/026/2020 dt. 08/07.2020.

In connection with the subject matter, the following officers from PWD and CMRL met today (29.10.2020) at CE, PWD WRO, Chepauk, Chennai and the following minutes are drawn.

PWD:

Sl. NO.	Name & Designation
1.	K. Asokan, CE, CR, HRD
2.	A. Muthiah, SE, Palar, HRD
3.	H. Yogapriya, AEE, HRD
4.	V. Manonmani, AE, HRD

CMRL:

Sl. No.	Name & Designation
1.	B.S Srinivas Chm(A&CM)
2.	S. Ashok Kumar GM (Tracks)
3.	A. Ramakrishnan RE (Civil)
4.	Koventhan (DDC)
5.	Anbu Ganapathy (DDC)

The elevated corridor C-5 from CMBT to Shollinganallur crosses Adyar river near Miot Hospital and also passes through Adambakkam lake . The general arrangement of elevated corridor, its pier arrangement etc., have already been shared for information by CMRL to PWD vide reference (1) above.

In this regard WRO, PWD has perused the arrangement and found it to be satisfactory. CMRL may accordingly proceed with the construction as per the arrangement submitted.

PWD 29/x/2020 CE/CE

29/x/2020 SE/Palar

CMRL

CGM(A&CM)

9-2. Fisheries Department

Chennai Metro Rail Limited

(A Joint Venture of Govt. of India and Govt. of Tamil Nadu)

MEETING WITH TAMILNADU FISHERIES DEPARTMENT

Lr No : CMRL/CONS/ES/612/2020 **Dated: 22.10.2020**

Sir,

Sub: CMRL – Chennai Metro Rail Project – Phase II – Metro Crossing at Adyar River near MIOT Hospital – Fishing activities.

We wish to inform you that the Phase II of the Chennai Metro Rail Project Corridor 5 (C5) passes along the Mount Poonamallee High Road, the elevated viaduct of the Corridor crosses the Adyar River near MIOT Hospital with the arrangements of 8 piers within the river.

This location inspected by Environmental Team of Chennai Metro Rail Limited and found there is no fishing activities or any habitats of fishermen in the nearby vicinity. Moreover the water condition etc., are not congenial for promotion of aqua culture for this location.

This is for your kind information and for necessary instructions.

Regards,

22/10/20.

M.Premnath
Environment Specialist
CMRL, Chennai.

xxx.

Tamil Nadu Fisheries Department
Teynampet, Chennai.

Today discussed with Tamil Nadu Fisheries Department officers Namely.
1. ALAN BRINDO Additional Director. Saidapet 9444054385
2. ELANGO Joint Director Theranpet. Incharge for. Chennai., Kanchipuram, Chingleput and Vellore District. 9443519820.
The Adayar River Not comes Under the Control of Tamil Nadu Fisheries Department because there is no Aqua Culture or fishing activities in this River.

23.10.20.
ES/CMRL.

CMRL Depot, Admin Building, Poonamallee High Road, (Opposite to Daniel Thomas School),
Koyambedu, Chennai - 600 107.
Phone : 23792000 Fax : 23792200
Email : chennaimetrorail@gmail.com website : chennaimetrorail.gov.in

9-3. Defense Estate Officer

Attachment : A-6

Chennai Metro Rail Limited

(A Joint Venture of Govt. of India and Govt. of Tamil Nadu)

o/c

CMRL/CON/PH-II/GM(T&E)/EXT/0013

17/10/2020

To

The Defence Estate Officer
Madras Circle,
306 Anna Salai, Teynampet,
Chennai - 600018.

CHENNAI METRO RAIL LIMITED
DESPATCHED BY
BP / OP / RP / SP / RPAD / SPAD
17 OCT 2020
TPL. REF. No:
TIME: 11.58am

Dear Sir,

Sub: Chennai Metro Rail Limited (CMRL) - Phase II Project - Alignment of C5 Corridor along Mt poonamallee road near Defense premises of Madras war Cemetery at Nandambakkam - Reg.

Ref: i) CMRL meeting with Estate officer at Teynampet office

CMRL has taken up the implementation of Phase II Chennai Metro project with 3 additional corridors C3, C4 and C5. In connection with the work we had a meeting at your office in Teynampet on 15.10.2020 and shared the corridor 5 alignment information along Mt poonamallee high road. The piers for the viaduct of corridor C5 is proposed in the median of Mt Poonamallee high road passing along Butt road and the War Cemetery is located away from the highways.

During the meeting with CMRL Resident Engineer and Estate officer discussion it was clarified that the alignment is passing on the road which is owned by Highways dept. Though we understand that No NOC is required since the premises of cemetery are away, for purpose of information the arrangement of alignment and a typical cross section of the elevated viaduct passing through this location is attached.

Thanking you,

Encl:

Yours faithfully

Alignment drawings and a cross section - 3dwgs.

General Manager (Tracks and EC)

CMRL Depot, Admin Building, Poonamallee High Road, Koyambedu, Chennai - 600 107.
Phone : 23792000 Fax : 23792200
Email : chennaimetrorail@cmrl.in website : www.chennaimetrorail.org
CIN : U60100TN2007SGC065596

9-4. AAI

Annexure : 4

Note

Date: 20.10.2020

Sub: Phase II project of CMRL – C5 Corridor – Airport Authority of India installation at Mugalivakkam – Reg.

****

In connection with the Corridor C5 the undersigned contacted Thiru V. Muruganandam, General Manager, CNS, Airport Authority of India, Chennai on 16.10.2020 and the arrangement of metro viaduct, its height etc., were appraised by CMRL to General Manager, CNS, Airport Authority of India. During the discussions, it was opined that an NOC is not required. However, GM, CNS, AAI advised to send the details of the alignment along with cross section for their information. He has further informed that , in case, if any NOC is required, he would advise as to how to proceed with the same and also assured that it would be given at the quickest possible time. Consequent to the discussions, a letter was issued to GM, CNS, AAI by CGM (A & CM) along with the details about the Elevated Corridor as per attachment vide lr.No.CMRL/CON/CGM(A&CM)/Phase II/Ext/014/2020 dt. 17.10.2020

CGM (A & CM)

DP

23/10/2020

9-5. TNFD

P.R. C.No. 223/2020 Dated : 23.10.2020

Chennai Metro Rail Limited

(A Joint Venture of Govt. of India and Govt. of Tamil Nadu)

MEETING WITH GUINDY NATIONAL PARK FOREST RANGE OFFICER

Lr No : CMRL/CONS/ES/613/2020 **Dated: 23.10.2020**

Today discussed with Forest Range Officer (FRO) in charge of Guindy National Park (GNP) comes under Tamil Nadu Forest Department (TNFD).

The Range Officer gave a brief note on Guindy National Park as follows:

1. In Tamil Nadu the Chennai the fourth largest city in the country. It has a spot of interest for the wildlife. One of the natural spectaculus of the city is a small but renowned Guindy National Park spreading over an area of 2.7 km^2. It is a great habitat of varied species of Fauna coupled with the Tropical Evergreen Forest of the Coromandel Coast. It is 8^{th} smallest national park. Initially it's game reserve spreading over 5 km^2. In 1672-1678 it is transferred into a space of residence called Guindy Lodge, Established by the Governor William Longhome.
2. The balance forest area owned by a British named Gilbert Roderick. He sold the Forest Land to Government for Thirty Five Thousand Indian Rupees.
3. This dry evergreen forest consists of 24 trees species. 350 plant species, 60 butterfly species and 130 bird species.

Then CMRL Environmental Team explained GNP FRO about the CMRL Phase II project profile and we handed over the copy of GoI letters and notifications perlaining to Environment, Forest and Wildlife Clearance about the exemption of Railways and Metros from Clearances.

M.Ponnath 23/10/20.
Environment Specialist
CMRL, Chennai.

Thiru N. Jothilingam,
Forest Range Officer
Guindy National Park,
Chennai.
Cell: 8428670692

Received

CMRL Depot, Admin Building, Poonamallee High Road, (Opposite to Daniel Thomas School),
Koyambedu, Chennai - 600 107.
Phone : 23792000 Fax : 23792200
Email : chennaimetrorail@gmail.com website : chennaimetrorail.gov.in

9-6. Additional Chief Secretary to Government

Annexure 6.

Chennai Metro Rail Limited

(A Joint Venture of Govt. of India and Govt. of Tamil Nadu)

PRADEEP YADAV, I.A.S.
Managing Director

Letter No.CMRL/CON/CGM(A&CM)/Phase-II/2020/16 Dated 23.10.2020

To

The Additional Chief Secretary to Government,
Environment and Forests Department,
Secretariat, Fort St. George,
Chennai – 600 009.

Dear Sir,

Sub: Chennai Metro Rail Limited – Phase-II Project – Corridor-5 – Transfer of Forest land to CMRL at Nanmangalam Reserve Forest at Medavakkam.

Ref: Minutes of the 20th High Power Committee Meeting held on 06.02.2020 (Item No.81).

****

In connection with the subject matter, it is brought to your kind notice that the Elevated Corridor C-5 between Vellakkal and Medavakkam Koot Road junction passes through the Nanmangalam Reserve Forest area along the side existing road.

To construct the elevated viaduct and one station, an area of 7570 sq.m. is required to be transferred to CMRL and the break-up of the same is as below:

1) Land for implanting permanent structure is 2535 sq.m.
2) The shadow area of viaduct is 4585 sq.m. wherein only the viaduct structure will be at a higher level thereby the land below can still be retained by Forest Department.
3) This subject was placed before the 20th HPC on 06.02.2020 as an agenda point under Sl.No.81 and it was decided by HPC that the Special Secretary (Environment and Forests) will further provide directions on this subject to CMRL and Forest Department.

In continuity, CMRL contacted the local DFO and CMRL was directed by him to apply online for the required land. However, CMRL is facing difficulty in filing online application as the same is not being accepted in the portal.

In addition, it has also come to the notice, that part of this land is with Quaid-E-Millath Educational and Social Trust, Chennai. In light of the above, it is requested that an Officer may please be nominated from Forest Department as the Nodal Officer on the subject matter and necessary directions may please be given to the concerned in this regard.

Thanking you,

Yours faithfully,

Pradeep

Managing Director