CHAPTER 6
ENVIRONMENTAL MANAGEMENT PLAN

6.1 APPROVALS/CLEARANCES

Project Management Unit (PMU) will have to ensure that all necessary approvals/clearances are in place before start of implementation. Permissions necessary are listed in **Table 6.1.**

Table 6.1 Necessary Approvals/Clearances

S. No	Issues	Provision of Laws & Regulations	Due Date	Approving Authority
Pre-Construction Stage				
1.	Permission for felling of trees and compensatory afforestation	Tree removal will be guided as per state government rules.	Before Construction	Greater Chennai Corporation/Forest Department
2.	Environmental Clearance for Depot, stations, property development	Amendment dated 9 December 2016 to EIA Notification 2006		Greater Chennai Corporation
3.	Archaeological / heritage assets	The Ancient Monuments and Archaeological sites and Remains (Amendment and Validation Act) 2010		National Monuments Authority for protected Archaeological assets / Greater Chennai Corporation for heritage assets
4.	Utility / traffic diversion	Respective Acts and Rules		Local Offices of respective Agencies.
5.	Consent to Establish Depot	Water (Prevention and Control of Pollution) Act 1974 ; Hazardous Waste (Management and Handling and transboundary movement) Rules 2016		TN State Pollution Control Board; CMDA for landuse clearance
Implementation Stage				
6.	• Consent to Establish and Operate hot mix plant, crushers, batching plant etc and • Consent to Establishlabour camps	Air (Prevention and Control of Pollution) Act 1981	Before Construction	• TN State Pollution Control Board • Greater Chennai Corporation
7.	Permission for	Environment	Before	Regional Director, Central

S. No	Issues	Provision of Laws & Regulations	Due Date	Approving Authority
	drawalof groundwater for construction (**not recommended**)	(Protection) Act, 1986	Construction	Ground Water Board and CMWSSB
8.	Authorization for Disposal of Hazardous Waste	Hazardous Waste (Management and Handling and transboundary movement) Rules 2016	Before Construction	TN State Pollution Control Board
9.	Consent for disposal of waste water from construction sites and sewage from labour camps	Water (Prevention and Control of Pollution) Act 1974	Before Construction	TN State Pollution Control Board
10.	Labour employment, safety, welfare measures	The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996	Before Construction	District Labour Commissioner
11.	Permission for management of C&D waste and muck	Environment Protection Act 1956	Before Construction	Greater Chennai Corporation and TN State Pollution Control Board
Operation Stage				
12.	Consent to Operate Depot	Environment Protection Act 1956	After Construction	TN State Pollution Control Board
13.	Installation and operation of DG sets at stations	Air (Prevention and Control of Pollution) Act 1981	After construction	TN Pollution Control Board

6.2 MITIGATION MEASURES

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

- **Location and Design**
  - Compensatory Afforestation,
  - Right of Way, Alignment and Architecture,
  - Spatial Planning of stations and Inter-Modal Integration
  - Provision for Green Buildings
  - Use of Energy and Water

- **During Construction**
  - Construction Material Management and Housekeeping
  - Hazardous Waste Management
  - Construction and Demolition Waste management
  - Energy Management
  - Labour Camp
  - Welfare of Labour on construction site
  - Safety of Labour
  - Utility Plan
  - Air Pollution Control Measures
  - Noise Control Measures
  - Vibration Control Measures
  - Traffic Diversion/Management
  - Soil Erosion Control
  - Muck Disposal
  - Dewatering of underground works

- **During Operation**
  - Noise and Vibration Management
  - Water Supply and Sanitation at stations
  - Rain Water Harvesting
  - Electro Magnetic Interference
  - Management Plan for Depot
  - Training & Extension

6.2.1 Location and Design

6.2.1.1 Compensatory Afforestation

Removal of air pollutants: Particulate matter in the atmosphere is intercepted by tree canopy. The particulates are retained on the plant surface or washed off by rain or dropped to ground with leaf fall. Urban trees have been found to remove PM10 and PM2.5 particulates from the atmosphere. Benefits in terms of reduced mortality. Removal of PM2.5 is lower than removal of PM10 but the health benefits are higher.*(Modeled PM2.5 removal by trees in ten US cities and associated health effects, David J Nowak, Satoshi Hirabayashi, Allison Bodine, Robert Hoehn, Elsevier, Environmental Pollution 178 (2013) 395-402).*

Ambient concentrations of SO2 was found to reduce by 39%, NOx by 40%, SPM by 37%, THC by 86%, CO by 93%, VOCs by 87.1% across the green belt and the overall air pollutant removal efficiency was calculated as 63% *(Assessment of Carbon Sequestration Ability of Trees for Adopting in Green Belt of Cement Industries in Karnataka, March 2016, Central Pollution Control Board Zonal Office South.*
Location for afforestation will be decided by CMRL in consultation with owner of the land as well Forest Department such that displacement does not become necessary.

Increase in groundwater recharge: Quantity of rainfall percolating to a specified depth of soil was found to decrease with distance from canopy edge towards with minimum percolating quantity in open area. Soil infiltration is improved near trees due to litter and tree roots promoting activity of earthworms, insects etc. resulting in increased soil macro porosity. Under conditions where surface runoff of rain water is redistributed towards trees, net water stored in soil near trees increases. In case of trees in which at least 25% of their water intake from soil is from depth greater than 1.5m, 10 trees per hectare with canopy cover 5% provide the highest groundwater recharge: tree density greater than this optimal cover showed reduced groundwater recharge. *(Intermediate tree cover can maximize groundwater recharge in the seasonally dry tropics, U.LIstedtetal, February 2016, www.nature.com).*

The Department of Forests, Government of Tamil Nadu is responsible for the conservation and management of trees/forests in the project area. According to the results of the present study, it is found that about 934 trees are likely to be lost along the two priority corridors and Madhavaram depot. It is proposed to plant twelve saplings for each tree to be cut. Hence 11,208 trees need to be planted. Estimated compensatory afforestation cost is about **Rs 51.98 Lakh** for Corridor-3 and **Rs 124.55 Lakh** for Corridor-5. The afforestation cost for Madhavaram depot is included under Corridor 5. Native plant species are recommended for afforestation.

Cost of compensation of trees which are to be felled and which are located in the privately owned land is to be finalized by the Tamil Nadu Forest Department prior to start of construction. Budgetary provision @ Rs 5000 per tree has been included in Chapter of 8 of the SIA report.

6.2.1.2 Right of Way, Alignment and Architecture

Alignment is kept elevated where adequate width of right of way on roads is available. Viaduct and elevated stations shall be shaped to minimize visual intrusion.

6.2.1.3 Spatial Planning of Stations and Inter-Modal Integration

Adequate and well-laid out space shall be designed for concourses and platforms, escalators, elevators and staircases, lighting, turnstiles for normal and abnormal operating conditions; optimal height / depth of the stations, forced ventilation shall beprovided. Physical and operational integration of metro with other modes shall be planned. Adequate design of stations and multimodal integration prevents and mitigates congestion at stations. Safety is improved.

6.2.1.4 Provision for Green Buildings

In accordance with the *GRIHA (version 2015)* norms, the following measures shall be implemented to a feasible degree in the stations and depots:

Control annual heat gain through favorable orientation and design of facades and trees; 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 rain water harvesting ; reduced landscape water demand; Ensure zero SWD post-construction by means of ground water recharge and recharge of groundwater aquifers by rainwater ; low ODP building materials, indoor air quality and comfort, low-VOC paints and adhesives, 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. Solar energy generation per year is estimated to be 8.97 Giga-watt-hr for Corridor 3 and 3.70 Giga-watt-hr for Corridor 5. The installation cost for solar system is about **Rs 505.81 Lakh** and **Rs 208.65 Lakh** for Corridor 3 and Corridor 5 respectively.

6.2.1.5 Use of Energy and Water

Requirement of electrical energy for climate control, lighting and other facilities at stations shall 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 and Depot where feasible.

The water requirement for stations and depots will be met through the municipal water supply system. Municipal water supply will be supplemented by rain water harvesting along viaduct and at elevated stations and in depots.Sewage from stations and depots will be led into municipal network.Water required for horticulture and toilets at Depot will be sourced from recycling of used municipal water

6.2.2 EMP during Construction

Measures to mitigate impacts observed during construction shall be implemented by Contractor and duly monitored by Owner in accordance with approved method statements. Their cost is part of engineering and track cost.

6.2.2.1 Construction Material Management and Housekeeping

Procedures for storage, handling and transport of construction material shall be prescribed in SH&E method statement approved for construction.

Housekeeping is to keep the working environment cleared of all unnecessary waste, thereby providing a first-line of defense against accidents and injuries. It is the responsibility of Contractor and all site personnel. Some of the measures are listed below:

- Full height fence, barriers, barricades etc. shall be erected around the site in order to prevent the surrounding area from excavated soil, rubbish etc, which may cause inconvenience to and endanger the public.

- All stairways, passageways and gangways shall be maintained without any blockages or obstructions. All emergency exits passageways, exits fire doors, break-glass alarm points, fire-fighting equipment, first aid stations, and other emergency stations shall be kept clean, unobstructed and in good working order.

- All surplus earth and debris shall be removed/disposed off from the working areas to officially designated dumpsites. Trucks carrying sand, earth and any pulverized materials etc. shall be covered while moving.
    - Unused/surplus cables, steel items and steel scrap within the working areas shall be removed to identified locations.
    - All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from work place to identified locations.
    - Empty cement bags and other packaging material shall be properly stacked and removed.

Storage is another requirement:

- Proper and safe stacking of material is of paramount importance at yards, stores and such locations for future use. The storage area shall be well laid out with easy access and material stored / stacked in an orderly and safe manner.
- Flammable chemicals/compressed gas cylinders shall be safely stored.

6.2.2.2 Hazardous Waste Management

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.

It shall be the responsibility of the contractor to ensure that hazardous wastes 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 approach only Authorized Recyclers for disposal of Hazardous Waste, under intimation to the Project Authority.

6.2.2.3 Construction and Demolition Waste Management

Construction and Demolition (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.

- Segregation and temporary storage of reusable and recyclable materials at identified locations. Transport recyclable materials to construction sites.
- sale of metal scrap and other saleable waste to authorized dealers

- The construction and demolition waste generated should be disposed at site identified by CMRL away from any water body or river bank.
- Identification of intended transport means and route.
- Obtaining permission, where required, for disposal.

Sites for waste disposal will be decided by CMRL before start of construction in consultation with respective authority like Municipal Corporation etc. such that the sites are away from residential areas and do not require displacement

6.2.2.4 Energy Management

The contractor shall use and maintain equipment so as to conserve energy and shall be able to produce demonstrable evidence of the same upon the request of officer of the Project Implementation Unit.

Measures to conserve energy include the following:

- Optimizing the use of tools, plants and equipment to perform tasks with correct power,
- Optimizing cable size and joint can control voltage drops,
- Use of energy efficient motors (90% efficiency or more) and pumps (at least 80% efficiency),
- Replacing inefficient lamps with the most efficient lamp for the purpose, taking into account size, shape, colour and output of the lamp,
- Use of energy efficient motors, pumps, tools, cabling, lighting, emission standard
- Engine of DG set shall complies with CPCB norms
- Promoting employees awareness and training on energy conservation.
- Planning in advance and selecting location to receive and store material such that these are at the least distance from the place of use. Such an approach will result in less energy being consumed since optimum energy will be expended for transport of material,
- Maintenance schedule - setting up a maintenance schedule to clean and replace lamps on a regular basis,

6.2.2.5 Labour Camp

The Contractor during the progress of work will provide, erect and maintain necessary (temporary) living accommodation for construction workers at locations away from construction sites.

Water supply, waste water and sewage treatment: Uncontaminated water for drinking, cooking and washing, health care, latrines and urinals, system for conveyance, treatment and disposal of sewage and solid waste; adequate and clean washing and bathing places shall be provided. Wastewater shall be discharged to the existing sewage network.

Solid Waste Management: Solid waste generated will be collected and transported to local municipal bins for onward disposal to disposal site by municipality. Solid waste management facilities will be arranged by the construction contractors.

Health care awareness and clinics: Construction workers are more prone to Infectious diseases such as HIV/AIDS. It should be prevented by following actions: Counselling, community events, clinic, coordination with local health authorities.

6.2.2.6 Welfare of Labour on construction site

Shelter at Workplace: At every workplace, shelter shall be provided free of cost, separately for use of men and women labourers. The height of shelter shall not be less than 3m from floor level to lowest part of the roof. Sheds shall be kept clean and the space provided shall be on the basis of at least 0.5m^2 per head.

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

First aid facilities: At every workplace, a readily available first-aid unit including an adequate supply of sterilized dressing materials and appliances will be provided. Suitable transport will be provided to facilitate taking injured and ill persons to the nearest hospital.

Day Crèche Facilities: At every construction site, provision of a day crèche shall be made so as to enable women workers to leave behind their children. At construction sites where 20 or more women are ordinarily employed, there shall be provided at least one temporary structure with sufficient openings for light and ventilation for use of children under the age of 6 years belonging to such women. There shall be adequate provision of sweepers and maid servants to keep the places clean.

6.2.2.7 Safety of Labour

Construction works shall be executed as laid down in the Safety Health and Environment (SHE) manual prepared by the Contractor and approved by PIU.

The SHE manual

- Describes the SHE interfaces between Employer and the Contractor.
- Details the processes by which the contractor shall manage SHE issues while carrying out the work under the contract.
- Describes by reference, the practices and procedures

The construction works shall be undertaken in accordance with all applicable legislation and Indian statutory requirements and guidelines-OHSAS 18001-1999: Occupational Health and Safety Management System and ISO 14001-2004: Environmental Management Systems.

The key elements of the SHE manual are as follows:

1. The unit responsible for co-ordinating and monitoring the Contractor's SHE performance;
2. Procedures for identifying and estimating hazards, and the measures for addressing the same; a list of SHE hazards anticipated
3. SHE training courses and emergency drills
4. SHE inspections to identify any variation in construction activities and operations, machineries, plant and equipment and processes against the SHE Plan and its supplementary procedures and programs: Planned General Inspection, Routine Inspection, Specific Inspection and Other Inspection
5. Safety Audit: SHE Audit to assess potential risk, liabilities and the degree of compliance of construction Safety, Health & Environmental plan and its supplementary procedures and programs against applicable and current SHE legalisation regulations and requirements of the employer.

   Electrical Safety Audit

   External SHE Audit
6. SHE Communication to communicate the Safety, Occupational health and Environment management measures through posters campaigns / billboards / banners / glow signs being displayed around the work site
7. SHE Reporting –reports, minutes, inspection reports, audit reports
8. Accident reporting and investigation
   - Reports of all accidents (fatal / injury) and dangerous occurrences to the Employer
   - Reporting to Govt. organisations
9. Investigations of Accidents and Dangerous Occurrences, Near misses and minor accidents
10. Prepare an Emergency Response Plan for all work sites including injury, sickness, evacuation, fire, chemical spillage, severe weather and rescue.

Workplace safety and occupational health shall be ensured with special focus on following areas:

a) Housekeeping
b) Working at Height and Falling objects and Danger areas
c) Lifting Appliances
d) Launching Operation
e) Construction machinery, tools equipment - Safe worthiness
f) employ qualified electrical personnel on site and requirements of electrical equipment, distribution etc
g) Lighting
h) Exposure of worker to use of exhaust or harmful gases in confined locations
i) Fire prevention, protection and fighting system
j) Corrosive substances
k) Demolition
l) Excavation and Tunnelling
m) Traffic Management
n) Personal Protective Equipment (PPEs)
o) Reporting which will contain results of monitoring and inspection