

Draft Initial Environmental Examination

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DRAFT Environment Impact Assessment for Kochi Metro Phase IA & IB, Kochi, Kerala

Asian Development Bank

January 2021

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List of Abbreviations

SNo.	Abbreviation	Extension
1.	AC	Alternate Current
2.	ADB	Asian Development Bank
3.	AECOM	AECOM India Private Limited
4.	AAQ	Ambient Air Quality
5.	AoI	Area of Influence
6.	BOCW	Building and Other Construction Workers
7.	C&D	Construction and demolition
8.	CGWA	Central Ground Water Authority
9.	CMP	Comprehensive Mobility Plan
10.	CPCB	Central Pollution Control Board
11.	CPHEEO	Central Public Health and Environmental Engineering Organisation
12.	CPR	Common Property Resource
13.	CTE	Consent to Establish
14.	CTO	Consent to Operate
15.	CSR	Corporate Social Responsibility
16.	CR	Critically Endangered
17.	CRZ	Costal Regulation Zone
18.	dB(A)	Decibel (A-weighted sound levels)
19.	DMRC	Delhi Metro Rail Corporation
20.	DPR	Detailed Project Report
21.	DG	Diesel Generator
22.	E&M	Electricity and Magnetism
23.	ERT	Emergency Response Team
24.	EN	Endangered
25.	EPC	Engineering, Procurement and Construction
26.	EPA	Environment (Protection) Act, 1986
27.	EAP	Environment Action Plan
28.	ESIA	Environment and Social Impact Assessment
29.	ESMP	Environment and Social Management Plan
30.	ESMS	Environment and Social Management System
31.	EMS	Environment Management System
32.	EHS	Environment, Health and Safety
33.	EMS	Environment Management System
34.	ETP	Effluent Treatment Plant
35.	FACT	Fertilisers and Chemicals Travancore
36.	FGD	Focus Group Discussions
37.	GoI	Government of India
38.	GoK	Government of Kerala
39.	GP	Gram Panchayat
40.	GHG	Green House Gases

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SNo.	Abbreviation	Extension
41.	GRM	Grievance Redress Mechanism
42.	GSS	Grid Substation
43.	HSE	Health, Safety and Environment
44.	IBA	Important Bird and Biodiversity Area
45.	ICW	Integrated Constructed Wetlands
46.	IGBC	Indian Green Building Council
47.	ILO	International Labour Organization
48.	IMD	Indian Meteorological Department
49.	INR	Indian Rupee
50.	IP	Indigenous People
51.	lpcd	litre per capita per day
52.	IS	International Standards
53.	ISA	Implementation and Support Agreement
54.	IUCN	International Union for Nature and Natural Resources
55.	KLD	Kilo Litre Per day
56.	KMRL	Kochi Metro Rail Limited
57.	KV	Kilo Volt
58.	KSPCB	Kerala State Pollution Control Board
59.	L&FS	Life and Fire Safety
60.	MARS	Monthly Audit Rating Score
61.	MoEF&CC	Ministry of Environment, Forest and Climate Change
62.	MoUD	Ministry of Urban Development
63.	MW	Mega Watt
64.	NAAQSN	National Ambient Air Quality Standards Noise
65.	NOC	No Objection Certificate
66.	NGT	National Green Tribunal
67.	OCC	operation control centre
68.	OM	Operational Manual
69.	O&M	Operations and Maintenance
70.	PM	Particulate Matter
71.	POC	Point of Contact
72.	PPE	Personal Protective Equipment
73.	PUC	Pollution Under Control
74.	PSAA	Private Security Agencies Act
75.	RDSO	Research Design and Standards Organisation
76.	RMC	Ready Mix Concrete
77.	RoW	Right of Way
78.	R&R	Rehabilitation & Resettlement
79.	SHE	Safety Health and Environment
80.	SPS	Safeguard Policy Statement
81.	SC	Scheduled Caste
82.	SCADA	Supervisory Control and Data Acquisition
83.	ST	Scheduled Tribe

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SNo.	Abbreviation	Extension
84.	STP	Sewage Treatment Plant
85.	SPV	Special Purpose Vehicle
86.	TL	Transmission Line
87.	ULB	Urban Local Bodies
88.	UIC	International union of railways
89.	VU	Vulnerable
90.	WMP	Waste Management Plan
91.	WPA	Wildlife Protection Act

Executive Summary

The Kochi Metro is a rapid transit system serving the city of Kochi in Kerala, India. A Special Purpose Vehicle “Kochi Metro Rail Limited (hereinafter referred as ‘KMRL’)” (SPV) has been formed by the Government of Kerala, on 2nd Aug 2011 for implementation, operation and maintenance of the Metro projects.

Phase 1 of Kochi Metro, covering ~25km with 22 stations has been commissioned since 2017. Kochi Metro Rail Limited (hereinafter referred as ‘KMRL’) has proposed to expand the Phase I of the Kochi Metro Rail from Petta to Tripunithura. Extension of Phase I measures 3.2 km in length and comprise of 3 no of stations, i.e. Vadakkekotta station, SN Junction station and Tripunithura terminal station. This extension is going to be developed in 2 phases i.e. Phase IA and IB.

Asian Development Bank (hereinafter referred as ‘ADB’) is considering provision of a senior secured loan to partially finance construction and operation of Phase 1A and Phase 1B of Kochi Metro Phase I extension (together, the “Project”).

AECOM India Private Limited (hereinafter referred as ‘AECOM’) has been appointed by ADB as an independent consultant to undertake an update of existing Environmental Impact Assessment (EIA) report prepared for Kochi Metro Phase I Extension in accordance with the requirements of the applicable framework and ADB Safeguard Policy Statement 2009.

Objective of the Environment and Social Impact Assessment study

- Reviewing the existing Environment Impact Assessment (EIA) and assessment of gaps with respect to reference framework requirements
- Updating the existing EIA in accordance with the requirement of the applicable framework and Safeguard Policy Statement (SPS)
- Prepare/Update the Environmental and Social Management Plan (ESMP) based on detailed assessment of potential environmental and social impacts and mitigation measures
- Preparing an ESMS aligned to KMRL’s operations.

Overall, the project will be implemented within applicable Indian legal framework and will also comply with the Applicable Safeguard Policies of the Asian Development Bank. As per the current regulations of Government of India, Railway projects do not require conducting Environmental Impact Assessment (EIA) studies for obtaining Environmental Clearance (EC) under EIA Notification 2006. However, the proposed project falls under the preview of the Costal Regulation Zone as per Costal Regulation Zone Notification 18th January 2019.

Project Description

Salient features of the project include:

Table E-1: Salient Features of the Project

Sr. No	Features	Details
1.	Length of the Proposed Alignment	3.2 km
2.	Station	3 Stations (Entirely Elevated)
		The land requirement for Road widening (including the bridge over canal), Vadakkekotta station and S N Junction station is 1.1907 hectares.
3.	Land Requirements (Permanent land)	Land requirement for Thripunithura station/terminal is yet to be finalised.
		The land is taken from two villages that are Nadama and Punithura in Ernakulam district of Kerala. Majority (99.11%) of 1.1907 ha is private land whereas government land is merely 0.88%.
	Land Requirements (Temporary land)	The land for casting yard is 2.5ha. It is leased by KMRL from M/s FACT

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4.	Traction system	750V DC third rail system
		Maintenance depot cum workshop: KMRL have a well-established depot-cum- workshop at Muttom village
5.	Associated Facility	FACT Casting Yard and Labour Camp Located in East Eloor Kalamassery
		Stock Yard and Labour Camp Located in Irumpananam
6.	Cost Estimation	Cost of the project is estimated to be INR 776.00 Crores

Stations have been located so as to serve major passenger destinations and to enable convenient integration with other modes of transport. The average spacing of stations is close to one km.

Table E-2: List of Stations for Phase I extension

S. No	Station Name	Chainage	Inter Stations distance (Km)	Phase
1.	Petta (Existing)	24.88		Under Phase-I
2.	Vadakkekotta	26.085	1.21	Under Phase-IA
3.	SN Junction	26.845	0.76	Under Phase-IA
4.	Trivunithura	27.78	0.936	Under Phase-IB

KMRL has achieved 30% physical progress on the construction activities for Phase IA stretch. It is reported that both Phase 1A and Phase 1 B are expected to be completed in March 2022 and March 2023.

The project is likely to be completed in a period of about 3 years. During construction phase about 500 persons are likely to work during peak construction phase. During the operations phase, KMRL shall require human resources for facility management services that include, ticketing, customer care, housekeeping, security, and gardening. This requirement is estimated to range between 100-200 persons.

Water will be required for domestic purpose of construction workers and staff and for carrying out construction activities, in batching plant for manufacturing of ready mix concrete (RMC), curing of structures, material mixing, etc. Water requirement for construction purpose & at casting yards is approx. 60 KL. Two labour camps have been set for an estimate of 500 employee/labour employed for construction of Phase I Extension. The water requirement at camp will be for activities such as drinking, cooking, personal washing, washing clothes etc, and hence a total of 55 KLD considering 500 persons @ 110 Lpcd.

Requirement of drinking water supply at an elevated station will be about 18 KL/day. The water consumption for domestic purposes at elevated stations would be 90 KLD. Thus, there would be total water requirement of 108 KLD in 3 stations. Arrangement of water will have to be made at each station separately. About 15 KLD of water will be required for operation and functioning of depot.

The construction works for the development of project will entail generation of wastewater from domestic use through workers, drilling and other civil work, curing at casting yard and other industrial wastewater from batching plant, etc. The slurry waste or other liquid waste generated during construction phase will be disposed of at location approved by KMRL. Wastewater generated at labour camp would be approximately 44 KLD of domestic sewage from 500 workers. Septic tanks and soak pits have been provided at labour camps.

During operation phase, wastewater will be generated due to workers as well as passengers which will be disposed with the help of local municipal wastewater handling system / sewer lines. The treated wastewater needs to be tested for Inland Water Discharge Standard before releasing into water body, if required. As far as possible treated wastewater should be recycled to use at station horticulture / flushing, etc. The wastewater to be generated at depots is treated by ETP & STP at the Muttom Depot. About 12 KLD of treated wastewater will be used for horticulture and flushing purposes at the depot.

Legal and Administrative Framework

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All the applicable policies, rules and regulations by Government of India (GOI), Government of Kerala (GoK), requirements of the applicable framework and Safeguard Policy Statement from Asian Development Bank and other best practices have been considered for preparation of Environment Management Plan in this report.

Baseline Environmental Profile

The core area for ESIA is considered as 500 m on either side from centre of proposed alignment. The buffer area is considered as 10 km radius area from centre of alignment area. Baseline monitoring was carried out in core and buffer area during the 6th to 11th of November 2020. Environmental monitoring was undertaken for ambient air, noise, ground water and surface water quality, in order to evaluate the environmental quality in the study area. Monitoring was carried out with help of M/s Poluchem Laboratories Private Limited, which is accredited to National Accreditation Board for Testing and Calibration Laboratories (NABL) in accordance with ISO/IEC 17025:2005 and as "A" Grade Laboratory by Kerala State Pollution Control Board (KSPCB). The construction contractor of KMRL also carries out monthly ambient air quality monitoring.

Ambient Air Quality:

The parameters measured for ambient air quality by AEOM were noted to be within the permissible limits of the National Ambient Air Quality Standards (NAAQS), as defined by MoEF&CC. PM_{2.5}, PM₁₀, SO₂, and NO₂ were detected in all the samples but were noted to be well within the permissible limits, while other parameters like CO, Pb, As, Ni, O₃, C6H6, Benzo (O) Pyrene (BaP), NH₃, were not detected at any of the locations.

The parameters measured for ambient air quality by KEC-CCECC were noted to be within the permissible limits of the National Ambient Air Quality Standards (NAAQS), as defined by MoEF&CC. PM_{2.5}, PM₁₀, SO₂, and NO₂ were noted to be well within the permissible limits, except PM₁₀ at Kalamassery (Pre -cast yard), which was slightly above the permissible limit for October. The one-time exceedance maybe attributed to construction activities being carried out.

Ambient Noise Quality: The ambient noise levels at all locations along the alignment was noted to be exceeding the permissible standards of noise levels prescribed by CPCB for daytime and night-time. The high noise level can be attributed to vehicular movements along with groundwork being undertaken.

Ambient noise levels at NQ7 i.e. Eloor Casting Yard and NQ8 i.e. Irumpanam Stock Yard are within permissible standards of noise levels prescribed by CPCB for daytime. Ambient levels were found to be exceedingly slightly above the permissible limits for night-time at NQ7. These exceedances could be attributed to night-time operations of Eloor Casting yard.

Vibration: The vibration velocity at all locations is well within the vibration limits specified in DIN specifications. Vibration limits at residential areas such as VB 1 to VB4 and VB6 fall within the recommended standards for dwellings and buildings of similar occupancy (5 mm/s). vibration levels measured at Milma diary is classified as "commercial" and the maximum vibration velocity recorded here too is less than that recommended for commercial establishments (20 mm/s).

Ground Water Quality: The pH value of the sample at the Eloor Casting yard accounting for 5.9 was observed to be lower than the acceptable limits of 6.5, indicating slightly acidic in nature. Coliform and E.Coli were observed to be absent at all locations. All other parameters were either within the permissible limit or below detection level, indicating that the drinking water was fit for human consumption, once it is treated for high pH.

Surface Water Quality: The pH of surface water sample was within acceptable range. Odour was disagreeable. Total Hardness (As CaCO₃) and alkalinity were in the range of 740mg/l. Total Coliform was present in low numbers. As per the CPCB Surface water quality criteria, the surface water falls under **Class C** which signifies Drinking water source after conventional treatment and disinfection. Mineral oil was not found. Pesticides were not found. Many metals such as Al, Mn, Ni, Cu, Boron, As, Se, Mo, Cd, Ba and Hg were below detection limit.

Ecology:

Flora:

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Type 4A/L1 [Type L1 (Littoral Forest) of Sub-group A (Littoral Forests) of Group 4 (Littoral & Swamp Forests)]

Species typical of this forest type include:

Tree species, such as *Barringtonia spp.*, *Calophyllum inophyllum*, *Casuarina equisetifolia*, *Cordia myxa*, *Dalbergia sp.*, *Erythrina variegata*, *Hibiscus tiliaceus*, *Morinda citrifolia*, *Pongamia pinnata*, *Terminalia catappa*, *Thespesia populnea* and *Vitex negundo*;

Shrub species, such as *Caesalpinia bonduc*, *Clerodendrum inerme*, *Ixora spp* and *Tamarix sp.*; and

Herb species, such as *Clitoria ternatea*, *Crotalaria spp.*, *Desmodium umbellatum*, *Mucuna gigantea* and *Vigna retusa*.

Type 4B/TS1 [Type TS1 (Mangrove Scrub) of Sub-group B (Tidal Swamp Forests) of Group 4 (Littoral & Swamp Forests)]

Species typical of this forest type include:

Tree species, such as *Aegiceras sp.*, *Avicennia alba*, *Avicennia officinalis*, *Excoecaria agallocha* and *Sonneratia apetala*;

Shrub species, such as *Acanthus ilicifolius* and *Clerodendrum inerme*; and

Herb species, such as *Cynodon dactylon* and *Derris trifoliata*.

Fauna:

At least 65 species of mammals have reported ranges that include the Study Area. Of these, 5 species were recorded in the Study Area as part of the primary data collected by EQMS or AECOM. Significant species with respect to the IUCN Red List include 1 species designated as Critically Endangered, 2 as Endangered and 3 as Vulnerable. Significant species with respect to the WPA include 7 species listed in Schedule I.

At least 327 species of birds, including 225 resident and 102 migratory species, have reported ranges that include the Study Area. Of these, 29 species, including 23 species of resident birds and 6 species of migratory birds, were recorded in the Study Area as part of the primary data collected by EQMS or AECOM. Significant species with respect to the IUCN Red List include 3 species designated as Critically Endangered, 3 as Endangered and 3 as Vulnerable.

At least 33 reptile species have reported ranges that include the Study Area. Of these, 3 species were recorded in the Study Area as part of the primary data collected by EQMS or AECOM. Significant species with respect to the IUCN Red List include 2 species designated as Vulnerable. Significant species with respect to the WPA include 4 species listed in Schedule I.

At least 17 amphibian species have reported ranges that include the Study Area. Of these, 2 species were recorded in the Study Area as part of the primary data collected by EQMS or AECOM. None of these species is designated by the IUCN as threatened or near-threatened or is listed in Schedule I of the WPA.

At least 147 fish species have reported ranges that include the Study Area. None of these species were recorded in the Study Area as part of the primary data collected by EQMS or AECOM. Significant species with respect to the IUCN Red List include 1 species designated as Critically Endangered, 6 as Endangered and 10 as Vulnerable. None of the species are listed in the Schedule I of the WPA.

Internationally Recognized Areas

Vembanad Kol Wetlands Ramsar Site

The Vembanad Lake wetlands ecosystem, referred to as the Vembanad Kol Wetlands, is internationally recognized as a Ramsar Site. It represents a shallow estuarine network running parallel to the coastline of Kerala and opening into the Arabian Sea at Kochi and Azhikode. The Ramsar Site reportedly covers an area of 151,250 ha.

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As per the map available on the RSIS, the proposed Project Site, as well as, the estimated Area of Influence (AoI) of the Project appears to be situated within the area designated as a Ramsar Site. However, the concerned map does not provide adequate geo-referencing to enable confirmation of the same.

Vembanad Lake KBA and IBA

An area of 79,400 ha area of the Vembanad Lake wetland system was accorded IBA status [IBA Code IN254] in 2004 owing to its significance as a congregatory site of 3 species - Anas querquedula, Chlidonias hybrida and Microcarbo niger, as well as, a habitat of a significant number of waterbirds as an avian group. An area of 59,359 ha of the Vembanad Lake IBA has qualified as a regional KBA, while being assigned priority for reassessment as a global KBA.

The central coordinates of the KBA site are: 9.60 N, 76.39 E. No part of the site is legally protected for biodiversity value.

As per the maps available on the KBA website and BirdLife Datazone, the KBA and IBA areas largely overlap each other and are situated approximately 1.7 km from the nearest point on the Project Site boundary.

Analysis of Alternatives

Kochi also known as the financial, commercial and industrial capital of the state of Kerala, is also the most densely populated city in the state. Kochi has witnessed urbanization, including commercial developments in the recent past which has added a demand on Kochi's transport infrastructure. Kochi's transport infrastructure is overwhelmed with transport demand. Public transport system effectively utilizes limited space by catering to a larger population at greater speeds.

Due to project, employment opportunity will rise leading to income level increase opportunity for unskilled/ semiskilled/skilled people to work in the project. Induced developments such as local transportation and other small businesses will cater to increasing population in the project area.

KMRL has conducted detailed field investigations and pre-feasibility study to understand the characteristics of the system, assess the present and future ridership in the project area along with accessing various alternatives in design technology and locations and selected the best options based on:

- Available RoW and land acquisition requirement
- Forest/wildlife/plantation with alignment or AOI
- Planned Government projects
- Existing/ under construction road infrastructure/ flyovers / ROBs
- Water channels
- Abutting structures including high-rise building and Railway infrastructure
- Land availability for stations, terminals/ depots and train operation planning

Accordingly, client has undertaken planning of alignment for the proposed routes.

Impact Assessment

The activities which will be carried out during construction and operation phase are considered for identifying impacts of the project. The activities during construction phase include clearing the ground for construction activity, dismantling / demolition activities, establishment and operation of the labour camps, access control and barricading, relocation and arrangements of utility lines for construction works, collection of construction material, transfer of construction materials, storage, handling and disposal of solid, hazardous and construction and demolition waste material, excavation works and foundation works, earth works, assembling and its mechanical installation of pre-fabricated components, operation and maintenance (O&M) of all machineries, electrical works as installation of overhead electrical structures, signalling post, power sub-station, etc. The operation phase would include activities like operation and maintenance of the viaduct, metro stations, other ancillary facilities etc. Key environmental and social components considered for impact identification are as follows:

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- Air Quality: Fugitive dust, gaseous emissions, fuel emissions, emissions from diesel generator sets, odour nuisance, etc.
 - Water Quality: Water withdrawal, water contamination, effect on the existing storm water drain
 - Land: Soil erosion, soil contamination, loss of productive soil/ land degradation
 - Noise & Vibration: Noise & vibration due to construction activities, maintenance activities, rolling stock movement, etc.
 - Biodiversity: Felling of trees, disturbance to ecology and biodiversity
 - Occupational Health & Safety: higher noise levels, mechanical vibrations, Exposure to hazardous materials, safety of workers, etc.
 - Community Health & Safety: impact on community infrastructures, health and safety of community, aesthetic changes

Environment, Social, Health and Safety Management Plan

Environment, Social, Health and Safety Management Plan (ESHSMP) has been prepared, based on the identified environmental attributes and type of the impacts. The enforcement and implementation of the project specific ESMP requires a robust manpower network working towards the common goal of ensuring compliance to the commitments towards ESHS standards for the project. Organization structure for the proposed project with project level responsibilities is given in figure below.

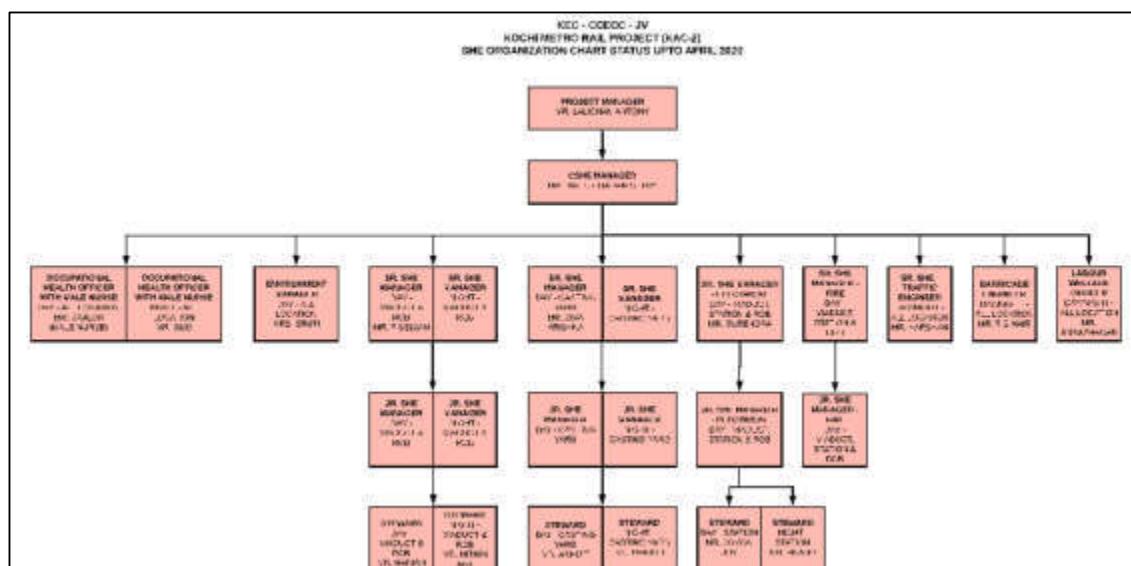


Figure E-1: Project Organization Structure

Source: Project Occupational Health, Safety & Environment Plan, dated 5th November 2020

The main environmental attributes consist of air, water, noise and vibration, land, flora-fauna, occupational health and safety and environmental health and safety. To cover all the environmental attributes, ESHSMP has been divided into following components.

- Waste Management Plan
 - Storm Water Management plan
 - Occupational Health and Safety Management Plan
 - Community Health and Safety Management plan
 - Traffic Management Plan
 - Environmental and Social Monitoring Plan
 - Emergency Preparedness Plan
 - Stakeholder Management Plan
 - Grievance Redressal Plan

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Table E-3: Key Environment Management Plan Aspects

Sr. No.	Critical Environmental Impacts	Applicable Project Activities	Details of Project Activities	Mitigation Measure
1.	Water withdrawal/ consumption from ground and surface water source	<ul style="list-style-type: none"> - Excavation works and foundation works (pile and concrete) - Earth works - Assembling and its mechanical installation of prefabricated components 	Water requirement is expected for the duration of 3 years during construction along with operation phase.	<ul style="list-style-type: none"> - The contractor shall arrange for water required for construction in such a way that the water availability and supply to nearby communities remain unaffected. - Rainwater harvesting/artificial recharge structures shall be provided, wherever feasible
2.	Noise due to existing and/or additional train movement	<ul style="list-style-type: none"> - Excavation works and foundation works (pile and concrete) - Operation and maintenance of the viaduct, Metro stations, other ancillary facilities. 	Noise levels will increase due to, vehicular movement for material transportation and use of heavy machinery & vehicles during construction and additional rolling stocks movement during operation.	<ul style="list-style-type: none"> - Construction barricading at the locations should be carried out - Trees plantation as a noise barrier - Measures to be included in the design to minimize noise and vibration during the Metro operation.
3.	Impact on health and safety of workers	<ul style="list-style-type: none"> - All the project activities during construction and operation stages 	It is envisaged that construction activities carried out will pose health and safety hazards like fall, high noise, work at height, electrical and hot work, etc. Operation and maintenance would also pose hazards like work at height, electrical and hot work, etc.	<ul style="list-style-type: none"> - Personal Protective Equipment (PPEs) e.g., shock resistant rubber gloves, shoes, other protective gear etc. should be provided to workers handling electricity and related components and monitored that they are used by the employees - Periodic inspection of PPE should be done to ensure that they are in proper condition by keeping the records - All the stations should be equipped with fire extinguishers and sand buckets at all strategic locations to deal with any incident of fire; - Functioning of metro, stations, electrical equipment & network, DG sets etc. should be audited and inspected by eligible third part on regular basis - The building and other construction workers' (regulation of employment and conditions of service) act, 1996 requirements shall be followed. - All hazardous chemicals and materials shall be stored in dedicated area and covered. - Ensure that a readily available first-aid unit and access to the ambulatory services - All machinery and equipment should be covered with acoustic materials. - Comprehensive traffic management plan should be prepared - The labor camp should be adequately drained to avoid the accumulation of stagnant water. - Drains and ditches within the labor camp area should be disinfected

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Sr. Critical Environmental No. Impacts	Applicable Project Activities	Details of Project Activities	Mitigation Measure
4. Dust and gaseous emission from heavy machinery and vehicles	<ul style="list-style-type: none"> - Clearing the ground for construction activity - Dismantling / demolition activities before construction - Transportation of construction material - Ready-Mix Concrete (RMC) Plant - Excavation works and Foundation works (Pile and concrete) - Earth works/Landfill works - Assembling and its mechanical installation of prefabricated components - Operation and maintenance of all machineries 	<p>Vehicle movement for material transportation, loading and unloading of material, installation and operation of RMC Plant, DG sets, dismantling activities, earthwork, etc. will generate dust and gaseous emission</p>	<ul style="list-style-type: none"> - Vehicles delivering loose and fine materials like sand and fine aggregates shall be covered. - Loading and unloading of construction materials, earthwork, unpaved haulage roads other dust prone areas and construction yard shall be provided with water spraying arrangement. - Vehicular pollution check (PUC) for all the vehicles - The excavated material shall be stored properly - The construction workers shall be provided with all requisite Personal Protective Equipment's (PPEs) like helmet, face masks, etc. - As far as possible, transport the material during night time (8 pm to 5 am). - Procure material only from approved quarry areas - Air quality monitoring for the same parameters, which were monitored during the baseline studies, shall be implemented by the Contractor by hiring the services of the NABL accredited / MoEF&CC notified laboratory
5. Impact on Health and Safety of Communities	<ul style="list-style-type: none"> - All the project activities during construction and operation stages 	<p>The duration of the construction activity is envisaged as 3 years which will generate inconvenience to the local community due to barricading, traffic diversion, increase in worker population, etc. and issues related to health and safety of the community</p>	<ul style="list-style-type: none"> - Work area should be barricaded and provided with measures to prevent trespassing. - All exhaust should be provided stacks to release of gaseous emission at safe height. - Efforts shall be made to avoid the storage of hazardous chemicals near any residential area. - The contractor shall deploy a team for Safety, Health and Environment management on the construction site as specified in SHE manual prepared by KMRL. - Traffic diversion and management plan shall be prepared prior undertaking diversion in consultation with RTO and same shall be shared with the public through appropriate media including

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Sr. Critical Environmental No. Impacts	Applicable Project Activities	Details of Project Activities	Mitigation Measure
6. Loss of productive soil due to construction activities	<ul style="list-style-type: none"> - Establishment and operation of the labor camps - Transportation of construction material - Storage, handling and disposal of solid, hazardous and construction and demolition waste material - Ready-Mix Concrete (RMC) Plant - Excavation works and foundation works (Pile and concrete) - Earth works/Landfill works 	<p>The loss of the productive soil will happen due to creation of new access road for material movement, movement of vehicles.</p>	<ul style="list-style-type: none"> - Periodic checking shall be carried out by the contractor to assess the effectiveness of stabilization measures viz. turfing, stone pitching, etc. - To prevent soil compaction in the adjoining productive lands beyond the RoW, the movement of construction vehicles, machinery and equipment shall be restricted to the designated haulage route. - Topsoil from sites should be conserved and restored after excavation is over. - Provide appropriate storage of topsoil in an isolated and covered area to prevent its loss during high wind and runoff. - Re-vegetation to be done in the area after the completion of construction, in order to reduce the risk of soil erosion. - Topsoil should be utilized the time of plantation. - Areas to be used temporarily shall for establishing casting yards, workshops, storage, labour camps shall be restored back to the original conditions.
7. Impact on ecology	<ul style="list-style-type: none"> - Clearing the ground for construction activity - Dismantling / demolition activities before construction 	<p>Total 1138 nos of trees fall in the area. As per DPR approx 106 trees may be cut (68 between Petta to Tripunithura) and 38 between Tripunithura and Petta).</p>	<ul style="list-style-type: none"> - Tree felling, clearing of vegetation and trimming of trees in accordance with the relevant regulations - Plan for compensatory planting - KMRL shall not allow introduction of exotic species

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Environmental Monitoring Plan

The key environmental performance indicators that will be used to evaluate the effectiveness of the proposed environmental safeguards in relation to community health and safety in the project area will be mainly air quality, water quality, noise & vibration level.

Air Quality Monitoring - The air quality monitoring is recommended through NABL accredited / MoEF&CC approved laboratory during the construction phase of the project. The monitoring of air shall be mainly conducted at the proposed stations, casting yard and stock yard. Air quality shall be analysed as per the National Ambient Air Quality Standards (2009), CPCB. The monitoring should be carried out at least once for continuous 24 hr, once every month during construction phase and 3 times in a year (3 seasons) in a year during operation phase and compared with the AAQ monitoring results obtained during the baseline monitoring to record changes in the AAQ and undertake suggested measures to mitigate the adverse impacts

Water Quality Monitoring - Water quality shall be monitored for surface water and groundwater having frequency of once in 3 months (4 times a year) throughout the project construction duration . Surface water should be monitored for parameters as per CPCB Designated Best Use classification and groundwater should be monitored for the parameters of IS:10500.

Noise and Vibration Level Monitoring - Noise and vibrations are to be monitored for 24 hours once every month during construction phase at proposed stations and casting yard and stock yard and once every month at stations during operation phase. Ambient Air Quality Standards in respect of Noise prescribed in Noise Pollution (Regulation and Control) Rules, 2000 (see rule 3(1) and 4(1)) shall be adopted for noise monitoring. Permissible limits of ground vibration specified by Director General of Mines Safety (DGMS) through its Circular No. 7 of 1997 or German standard guideline 'DIN 4150-3: 1999-02 - Vibration in buildings - Part 3: Effects on structures' can be used for assessing vibration.

Budgetary Provision for ESMP Implementation

The ESMP implementation will not be successful without a proper designated team and financial support for the same. Adequate budgetary provision will be made by the KMRL for execution of environmental management plan.

1. Introduction

Government of Kerala had proposed the Kochi Metro rail network (elevated) as rapid transit system. For this purpose, Kochi Metro Rail Limited (hereinafter referred as 'KMRL') a Special Purpose Vehicle (SPV) was formulated by the Government of Kerala, on 2nd Aug 2011 for implementation, operation and maintenance of the Metro projects. The Phase 1 of Kochi Metro Rail project was approved in the Union Cabinet on 3rd July 2012. Phase I of Kochi Metro covers approximately 25km with 22 stations and has been commissioned since 2017.

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AECOM India Private Limited (hereinafter referred as 'AECOM') has been appointed by ADB as an independent consultant to undertake an update of existing Environmental Impact Assessment (EIA) report prepared for Kochi Metro Phase I Extension in accordance with the requirements of the applicable framework and ADB Safeguard Policy Statement 2009.

This assessment has been based on the requirements of the ADB Safeguards Policy Statement 2009 (SPS 2009) and where available and applicable, local regulations and requirements. The purpose of this report is to provide a narrative context, findings summary and discussion of the outcomes, lessons and process completed as a part of this process.

1.1 Objective and Scope of Work

KMRL has developed an Environmental Impact Assessment (EIA) Report for Kochi Metro Rail Phase I Extension "Petta to Tripunithura Terminal", Kochi, Kerala prepare by EQMS India Pvt. Ltd, for the two phases in compliance with the statutory requirements. The scope of work for the proposed task entails updating the existing EIA in accordance with the requirement of the applicable framework and Safeguard Policy Statement (SPS) along with:

- a) Reviewing the existing Environment Impact Assessment (EIA) and assessment of gaps with respect to reference framework requirements
- b) Updating the existing EIA in accordance with the requirement of the applicable framework and Safeguard Policy Statement (SPS)
- c) Prepare/Update the Environmental and Social Management Plan (ESMP) based on detailed assessment of potential environmental and social impacts and mitigation measures
- d) Preparing an ESMS (brief and concise) aligned to KMRL's operations.

1.2 Applicable Reference Framework

The following reference framework was referred to while updating the ESIA report and ESMP:

- ADB Safeguard Policy Statement (SPS), 2009;
- ADB Social Protection Strategy, 2001;
- ADB Gender and Development Policy, 1998;
- ADB Access to Information Policy, 2019;
- World Bank Group / International Finance Corporation (IFC) Environment, health and safety (EHS) as well as sector specific guidelines such as Environmental, Health, and Safety Guidelines for Railways, April 2007

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- International Covenant on Economic, Cultural and Social Rights and relevant International Labour Organization (ILO) Core Labour Standards Conventions; and Other relevant good industry practice guidelines and related documents
- Applicable local, national and international environmental and social legislations

1.3 Approach and Methodology

The following approach and methodology was adopted by AECOM to carry out this assignment.

- Project Kick-off Meeting
- Desk based review of project related documents
- Site Reconnaissance
- Establishment of Environment and Social Baseline
- Impact Assessment & Mitigation
- ESMP preparation

1.3.1 Project Kick-off Meeting

The project kick-off meeting was conducted on 9th October 2020 wherein the ADB, KMRL's team and AECOM's team were present. The call started with introduction of all team members. This was followed by KMRL's presentation of project details and current status and AECOM's presentation on their approach and methodology on the study. Project associated modalities like point of contact from KMRL (Ms. Alex Seenii) and AECOM (Ms. Shubhangi Jadhav) were decided.

AECOM provided with Documentation Request List (DRL) to the ADB and KMRL following the introductory meeting.

1.3.2 Desk Based Review

Desktop review was conducted to identify the issues that are most likely to be of significance for the Project. As per the DRL, documents received from the ADB and KMRL were reviewed by AECOM team such as existing EIA report (Phase IA & IB), Social Impact Assessment (SIA) report, documents relating to right of way / land acquisition, private land purchase which are available for the Project, information related to land purchase/acquisition for the project.

The purpose of the document review was to understand the project and associated impacts, status of various applicable environmental and social permission / approvals and to identify gaps with respect to the project's reference framework.

1.3.3 Site Reconnaissance

A site reconnaissance visit was conducted to the construction site and associated facilities (such as casting yard, labour camps, maintenance depot, etc.) to assess the site conditions.

The site visit was conducted from 3rd to 5th Nov 2020 by AECOM team comprising of:

- Chetan Zaveri (Project Director and Peer Reviewer)
- Shubhangi Jadhav (Project Manager and Environmental Expert)
- Deepti Bapat (Ecology Expert)
- Dr. Basobi Sheel (Social Expert)
- Shahezan Issani (Environment Expert)
- Pranalee Balsaraf (Social Expert)

The entire project alignment was visited by the Project Team. The core area for the Study was considered as 500 m on either side from centre of proposed alignment. The areas visited included:

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- Project alignment from Petta to Tripunithura station area (with detailed inspection of Petta station site, Chambakkara Canal area, Vadakkekotta station site, S.N. Junction station, Tripunithura station area, associated development area along site)
- Casting Yard and Labour Colony at Eloor
- Maintenance Depot at Muttom
- Material Storage Yard and Labour Colony at Irumpanam

Consultations were conducted with various key stakeholders to understand project related environmental and social related compliance aspects. The key consultations included:

- KMRL team (Finance Head, Legal Team Lead, Environment Team Members, and HR)
- Chief Agricultural Officer, Department of Agriculture, Government of Kerala (GoK)
- Executive Engineer, Department of Irrigation, GoK
- Joint Director, Department of Fisheries, GoK
- Beat Forest Officer of the Mangalavanam Bird Sanctuary, GoK
- Administrative Assistant, Social Forestry Wing, Forest Department, GoK
- Land Acquisition Officer, Ernakulam
- Site visit to S.N. Junction, Vadakkekotta Station and Tripunithura Station Area
- Regular travellers / daily commuters along the project alignment
- KMRL'S contractor - KEC International Ltd. for EHS related documentation review
- Traffic controllers (men & women) at the Project Site
- Caretakers/religious heads at Religious structures like temples/mosque/church at Petta & Tripunithura
- Fishermen near Chambakkara Canal area and Commercial Structure Owners along proposed Project Alignment

The following aspects were taken into consideration for the gap assessment:

- Review of the environmental, health and safety and social management documents received from the KMRL
- Site observations along the project alignment and associated facilities such as labour/staff accommodation, casting yards, etc.
- Status of applicable environmental permits for the current phase of the Project
- Informal discussions with the community in the immediate vicinity and adjacent to the right-of-way (RoW) of the project area
- Consultations with the KMRL and contractor employees engaged in the project construction

1.4 Limitation

Professional judgements expressed herein are based on facts and information provided by the client. Wherever AECOM has not been able to make a judgement or assess any process, it has highlighted that as an information gap and suggested a way forward. AECOM shall not be held responsible for conditions or consequences arising from relevant facts that were concealed, withheld, or not fully disclosed by the company representatives, contractors, lenders and other relevant stakeholder engaged during the time of this assessment.

The ESIA study of the project is limited to project information made available by the client, discussion with KMRL representative, primary monitoring, secondary data collected, consultation with local community and observations made during site survey. Professional judgement and interpretation of facts has been applied for presenting inference from the collected information.

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Nothing contained in this report shall be construed as a warranty or affirmation by AECOM that the site and property described in the report are suitable collateral for any loan or that acquisition of such property by any lender through foreclosure proceedings or otherwise will not expose the lender to potential environmental or social liability.

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The assignment was carried out during pandemic conditions related to the Coronavirus disease (COVID-19). This health emergency has been impacting multiple facets of the life including, without limitation, labour, personnel, manufacturing, equipment, materials, transportation and related supply chains, and tasks such as travel for site visits and obtaining environmental database reports and other data from government agencies, all of which have the potential to adversely impact the critical path of the project. AECOM had taken all reasonable care to mitigate the potential impact of the Coronavirus to the extent within AECOM's reasonable control. Additionally, in view of COVID-19 pandemic, maximum usage of desktop study was done keeping field exposure to minimum, wherever required.

1.5 Layout of Report

The current ESIA Report has been arranged under the following chapters:

1. **Chapter One: Introduction** (This chapter provides a background of the project and the current Report, the objectives with which the study has been undertaken, the scope of work, etc.)
2. **Chapter Two: Project description** (This chapter provides details of the project location, site settings, resource requirement and procurement, waste generation and implementation of the Schedule etc.)
3. **Chapter Three: Applicable Policy, Legal and Administrative Framework:** (This chapter encompasses the Terms of Reference, National and Regional Enforcement authorities, acceptable Environment and Social Laws, policy framework in India, applicable international Standards and Guidelines, categorisation of the Project and applicable environment Standards)
4. **Chapter Four: Environmental and Socio-Economic Baseline** (This chapter illustrates the environmental baseline, socio-economic baseline and Ecology baseline)
5. **Chapter Five: Stakeholder Participation and Consultation**
6. **Chapter Six: Analysis of alternatives** (This section presents the analysis of alternatives for the proposed metro rail project)
7. **Chapter Seven: Impact Assessment** (This chapter highlights the impact assessment criteria, key environmental risks and key social risks)
8. **Chapter Eight: Environment and Social Management Plan** (This chapter highlights the organization structure, training, Inspection monitoring and audit and Documents and record keeping)
9. **Chapter Nine: Conclusion and Recommendations**

2. Project Description

KMRL has proposed to expand the phase I of the Kochi Metro Rail from Petta to Tripunithura, which has been approved by the Government of Kerala (GoK). Extension of phase I measures 3.2 km in length and comprise of 3 no of stations, i.e. Vadakkekotta station, SN Junction station and Tripunithura terminal station. Extension of the Phase 1 project is being proposed in two phases Phase as follows:

- Phase 1A from Petta, Terminal Station of the Phase 1 to S.N Junction for a length of 2.0 km with two stations, i.e. Vadakkekotta station, SN Junction station; and
- Phase 1B from S.N Junction to Tripunithura where the Metro rail connects to the existing railway station, for a length of 1.2 km.

With these two essential extensions to take the Kochi metro Phase 1 to the historical township of Trippunithura, the total phase 1 became 28.125 KM with 25 stations. For Phase 1A, the land acquisition (LA) process is completed, and pre-construction civil works has commenced. For Phase 1B, the land acquisition process is currently underway. Phase 1A and Phase 1 B are expected to be completed in March 2022 and March 2023, respectively.

2.1 Project Location

Kochi metro Phase I extension route is proposed within the Ernakulam district in Kerala. The Phase I extension initiates from the existing S.N Junction metro station which is located on the Kochi-Dhanushkodi State Highway 15 which is approximately one Km away from Tripunithura Town. The alignment turns towards National Highway 85 where it traverses along the median and road edges on existing road until SN Junction. The alignment passes through the Chembakkara canal on its way to SN Junction. Thereafter the alignment takes a turnover the road bridge and runs parallel to the Railway line terminating at Tripunithura railway station road. Metro alignment to Tripunithura Railway Station from the proposed S.N Junction Metro Station was finalised to be about 0.968 Kms. As part of the extension, the Panamukkutty Bridge along the proposed stretch at the Chembakkara canal has been under reconstruction. KMRL is also constructing an additional two-lane bridge with a footpath, which will convert the stretch into a four-lane corridor once completed

Land use of the RoW and the surroundings is mix of residential and commercial till the SN Junction, thereafter the land use parallel to the railway line are agricultural and marshy wetlands.

The Project is being developed as elevated metro project for which the land is required for road widening, construction of piers (RoW) and stations. Land is also required at two locations for temporary establishment of casting and storage yards which are identified at Kalamassery and Eloor FACT Casting Yard respectively. Distance of these casting and storage yards from Phase I extension alignment is 11 km and 12 km respectively in North direction. The Project will utilize existing maintenance depot at Muttom of Phase I metro project.

The location caters to the traffic from both Eastern & Southern sides of Ernakulam. Tripunithura Municipality is planning to build a Bus Depot near to the Railway Station which will act as a catalyst to develop the area as a multimodal transport hub of Railway, Metro & Bus Transport, eventually will become the entry point to the city there by increasing the Passengers per hour per direction of the entire Metro Corridor.

Salient features of the project are illustrated in Table 2-1. Figure 2-1 illustrates project location map including the associated facilities.

Table 2-1: Salient Features

S. No	Salient Features	Details
1.	Route Length (From End to End)	1.2 Km
2.	Number of Stations (Ph-IB)	<ul style="list-style-type: none">3<ul style="list-style-type: none">Vadakkekotta station

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S. No	Salient Features	Details
		<ul style="list-style-type: none">• SN Junction• Tripunithura station
3.	Headway in Min (Trains/hr)	4
4.	No of Cars/ Train	84
5.	Voltage	750 V DC
6.	Rolling Stock	2.9 m wide modern rolling stock with stainless steel body, Standard Gauge
7.	Capacity of 3 coach unit	766 passengers @ 6 pass/m ² , 975 @ 8 pass/m ²
8.	Maintenance Depot	Current Depot of Phase I at Muttom can cater the requirement for Phase IA and B too. (10° 4'27.34"N, 76°20'15.60"E)
9.	FACT Casting Yard and Labour Camp	Located in East Elloor Kalamassery, (10° 3'53.21"N, 76°18'56.96"E)
10.	Stock Yard and Labour Camp	Located in Irumpanam (9°58'16.83"N, 76°21'16.36"E)

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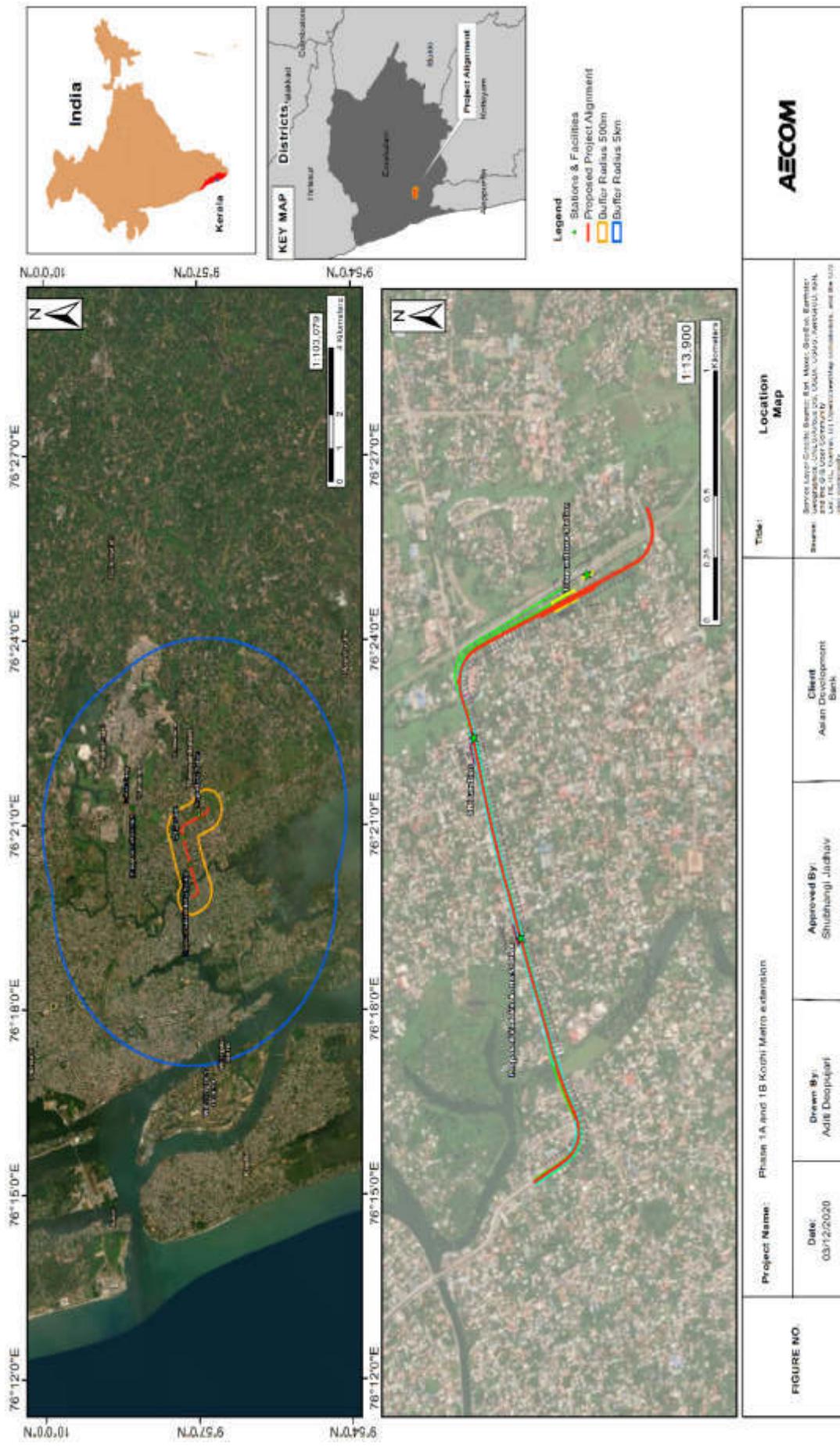


Figure 2-1: Kochi metro Phase I Extension Location Map

2.2 Project Overview¹

Majority of the Project alignment passes through existing roads. However, some private land acquisition, mainly for stations, electric sub-stations, maintenance yards etc. as well as a rail over bridge will be involved as part of preparatory work to manage traffic especially during construction phase. Land acquisition for the Project is under way, with negotiation with the landowners and stakeholder.

KMRL is working on piling of the viaduct from Petta to SN Junction. KEC International Ltd (KEC). In joint venture with China Civil Engineering Construction Corporation (CCECC) {Hereinafter referred as KEC-CCECC JV} is contracted by KMRL for construction of the Phase IA and for Phase IB stretch from SN Junction to Tripunithura Terminal has been awarded to KEC and Vijay Nirman Company Private Limited (VNC) {Hereinafter referred as KEC-VNC JV}.

During site visit KMRL had achieved around 30 per cent physical construction progress on the stretch. During the site visit the construction work was under progress along Petta to S N Junction station area, which included viaduct work. As part of preparatory works for Kochi Metro project, KMRL is constructing an additional two-lane bridge on Chembakkara Canal.

The casting yard and labour colony at Kalamassery, which were used for Phase I of metro project, are being used for this Project as well by KEC-CCECC. Apart from this, there is material storage yard and labour colony at Irumpanam which is being used and managed by KEC-CCECC. The maintenance depot at Muttom, which is being used for maintenance activities by Phase I metro project, will be used for Phase IA & IB.

2.2.1 Proposed Alignment

M/s RITES have carried out a detailed study on different options available for extending Metro Phase I to Tripunithura and found that the most viable option is to connect the Metro alignment to Tripunithura Railway Station which is about 1.2 Kms from S.N Junction Metro Station.

Planned alignment under phase I extension starts at Petta station and will end at Tripunithura Terminal. From the Petta metro station on Ettumanoor- Ernakulum road, alignment takes left turn on to the refinery road to reach SN Junction just after 130 m. Existing Row of the road at this point is 15 m. Due to site constraints the alignment has to take sharp turn with a radius of 125 m to run along the Refinery road to minimize the acquisition of Properties. However, acquisition of some properties is inevitable due to heavy built up areas at both sides. After turning on Refinery Road alignment generally follows the course of the road.

Alignment has to detour from Chainage 0/400 to Chainage 0/730 to keep the distance of minimum 10m from edge of the existing bridge on Tripunithura back water Channel to the central line of alignment. It then follows the centre of ROW and traverses through SN Junctions. The alignment after reaching the road over bridge (ROB) takes right turn towards Tripunithura railway station and runs parallel to the railway line to reach the proposed terminal station and terminus point.

2.2.2 Proposed Metro Stations

A typical urban metro corridor is planned with stations to be within a comfortable walking distance of about 700-1000m for the majority of catchment area population. Stations of the Project have been located so as to serve major passenger destinations and to enable convenient integration with other modes of transport.

For Phase IA there are two stations proposed, i.e. Vadakkekotta and SN Junction. For Phase IB only one station i.e. Tripunithura Station has been proposed for SN Junction to Tripunithura corridor. This Tripunithura metro station is in close vicinity of existing Tripunithura railway station. The list of stations is presented in Table 2-2.

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Table 2-2: List of Stations for Phase I extension

S. No	Station Name	Chainage	Inter Stations distance (Km)	Phase
1.	Petta (Existing)	24.88		Under Phase-I
2.	Vadakkekotta	26.085	1.21	Under Phase-IA
3.	SN Junction	26.845	0.76	Under Phase-IA
4.	Trivunithura	27.78	0.936	Under Phase-IB

All stations are considered elevated with 81 m platform length with 5.5m wide side platforms above central median will be developed. The rail level will be approximately 12.5 m above the road level if concourse is provided below the station structures. These levels will, however, vary marginally depending upon the actual location of stations. Levels can further be reduced to approximately 8.5m in case land is available for providing entry /exit and other structures at the road level.

As discussed with KMRL two types of typical plans and cross sections have been considered depending upon the site locations to minimize the property acquisition (Figure 2-2 and Figure 2-3). The stretches where the ROW of roads is not adequate to have sufficient open space (preferably 3.5m; minimum 2m) between entry/exits and the property lines, the entry / exits are planned in perpendicular shape to avoid blocking of the entries of buildings/ shops. On other locations preferable type i.e. entry / exits parallel to the alignment have been planned.

Being the terminal station of Phase 1 stretch in the southern side, it is proposed to have a bigger station with 120 x 40 m size at Thripunithura Terminal. The larger width is coming as a result of the third line planned in the station as a part of stabilizing line. Also, additional six floors for property development is considered above the platform level of main station structure itself.

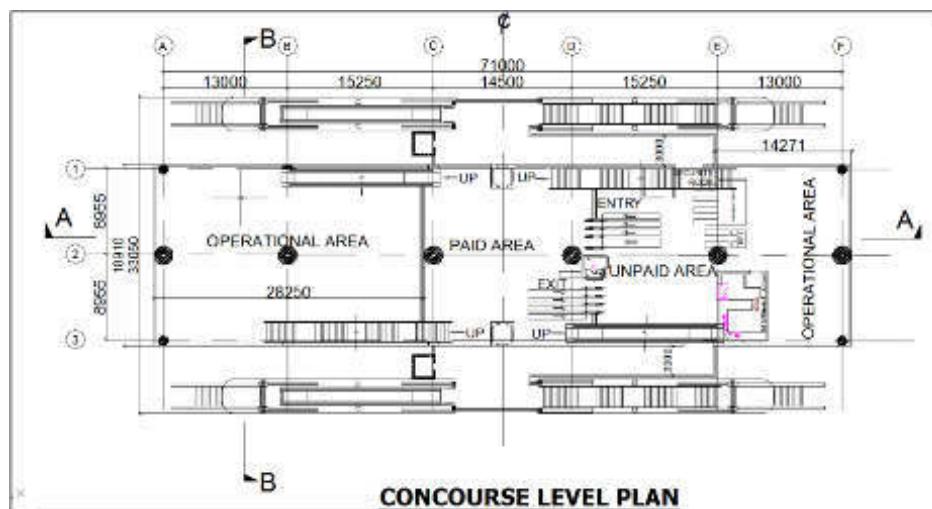


Figure 2-2: Typical plan of Elevated stations with parallel entry / exits

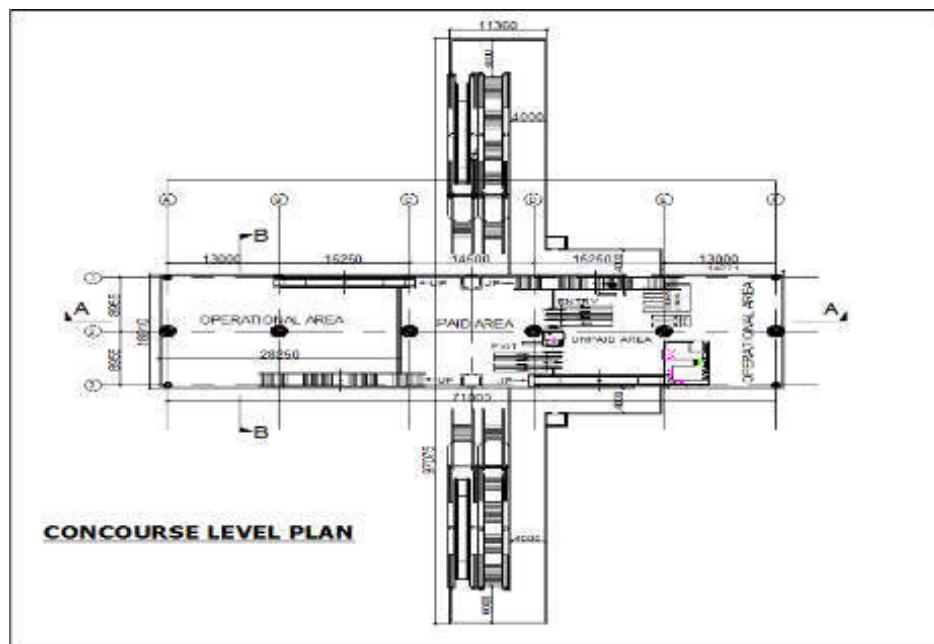


Figure 2-3: Typical plan of Elevated stations with perpendicular entry / exits

2.2.3 Geo technical Investigations ²

A total of 5 bore holes were drilled at an average distance of about 1000m each along Petta-Tripunithura corridor. Geotechnical investigations were carried out along the corridor up to a depth of 30m. Soil and rock samples were collected and tested in laboratory. The soils in and around the Kochi City vary from lateritic soils on the northern part to the marine clays on the southern part of the city. From Kochi towards Aluva, it is found that lateritic soils in the top layer's changes to granitic rocks in the lower strata.

2.2.4 Identification of Utilities and Their Diversion

The proposed Metro alignment is passing along major arterial roads of the city road network, which are serving institutional, commercial and residential areas. Large numbers of sub-surface and over-head utility services like; sewers, water mains, storm water drains, telephone cables, electrical transmission lines, electric poles, traffic signals etc. are existing along the proposed alignment.

The sewer / drainage lines and water mains running across the alignment and getting affected by the normal location of column foundations are proposed to be taken care of by relocating column supports of viaduct by change in span length or by suitably adjusting the layout of pile foundation. Where, this is not feasible, these utilities lines will be suitably diverted. Details of affected utilities along the corridor are indicated in Table 2-3.

Table 2-3: Affected utilities along the corridor

S. No	Utility	Authority
Water Supply line		
1.	150mm Dia. AC Pipe	Kerala Water Authority
2.	100mm Dia. AC Pipe	Kerala Water Authority
3.	300 Mm Dia. Ci Pipe At 1 M Depth	Kerala Water Authority
4.	400 Mm Dia. Premo Pipe	Kerala Water Authority
5.	500 Mm Dia Pipe	Kerala Water Authority
6.	300 / 280/ 200/ 150 /80 Dia Ac Pipeline	Kerala Water Authority
7.	110mm Pvc Pipe	Kerala Water Authority

² KMRL, DPR-ALUVA- TRIPUNITHURA and SN Junction to TRIPUNITHURA

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S. No	Utility	Authority
Fuel Supply line		
8.	6*600 Mm Dia. Pipeline (I. Petrol/Naphta P/L, 2 Disel/Keroseen P/L)	Indian Oil Corporation Limited
Electrical Line		
9.	11kv UG. Cable Kottaram Feeder from New Vytala Sub-Div.	Kerala State Electricity Board
10.	11kv UG. Cable for Poly Formalin Ltd	Kerala State Electricity Board
11.	300sqmm Tripunithura Feeder 11kva From New Vytala Sub Station, Depth-1m Approx.	Kerala State Electricity Board
12.	11kva,300sqmm, U/G Cable KSEB Udayamperoor Feeder.	Kerala State Electricity Board
13.	11kva OH Line Tripunithura Feeder Line	Kerala State Electricity Board
14.	Line Proposed to Be U/G Rapdrp Scheme Purnshree Ab To Milma Gate.	Kerala State Electricity Board
15.	Udayamperoor 11kv Feeder Ohline	Kerala State Electricity Board
16.	11kv OH Line Udayamperoor Feeder Milma to Tripunithura Depot	Kerala State Electricity Board
BSNL Cable		
17.	3*96F OFC CABLES	Bharat Sanchar Nigam Ltd.
18.	3*24F OFC CABLES	Bharat Sanchar Nigam Ltd.
19.	2x100 Pair Distribution Line to Pillar No. 61	Bharat Sanchar Nigam Ltd.
20.	1x1200 Pair Main Line and 1x200 Pair	Bharat Sanchar Nigam Ltd.
21.	1x200 pair Pillar No.67	Bharat Sanchar Nigam Ltd.
22.	2x400 Pair Primary (Pillar No:61)	Bharat Sanchar Nigam Ltd.
23.	DP-1X50 Pair	Bharat Sanchar Nigam Ltd.
24.	1x100 Pair Pattanchery Line	Bharat Sanchar Nigam Ltd.
25.	Kolatheri Line -2x100 Pair Pillar No 67 To 61	Bharat Sanchar Nigam Ltd.
26.	At Ch:1100 Pillar No. 37 Distribution 1x800pair,1x400 pair	Bharat Sanchar Nigam Ltd.
27.	Pillar No. 34 Distribution 3x200pair,2x400 pair	Bharat Sanchar Nigam Ltd.
28.	From Pillar No. (Lhs) Distribution 1x800, 2x400 & 2x200 pair	Bharat Sanchar Nigam Ltd.
29.	From Pillar No. (Lhs) Distribution 2x1200, 5x800, 2x400 & 2x200 pair	Bharat Sanchar Nigam Ltd.
30.	At Sn Jn. Eror To Kottayam Road	Bharat Sanchar Nigam Ltd.
31.	Pillar No. 45 Distribution 2x200pair,1x400 pair and 2x200 pair	Bharat Sanchar Nigam Ltd.

2.2.5 Religious Structures

All the efforts have been made during the design of alignment for these corridors to avoid any types of religious structures. Some of religious resources like church, mosque etc. were observed along the alignment of the project. Religious structures along the proposed RoW are St. Joseph Church (9°57'9.78"N, 76°20'16.95"E), Thajul Islam Juma Masjid (9°57'1.26"N, 76°19'59.20"E) and Adampillikavu Devi Temple (9°57'12.92"N, 76°20'27.97"E).

ST George Church at Tripunithura lost land for which the compensation amount has been paid, however, project will not affect the main structure of the church. In addition, the church on its front side had Saint's statue that needed to be shifted, the shifting was done by the project. Shiva temple in Tripunithura area where portion of temple boundary was affected, due compensations have been paid to the Temple Trust. Shree Vaishnava Gandharva Temple at Chambakkaran lost its boundary and parking area, compensation amount paid to the trust. Similarly, the viaduct is planned in such a way near mosque, that its main structure is unaffected. However, area lost parking and the boundary due to road widening work, the mosque authorities have been paid the compensation amount at mosque location, the clearance of viaduct from open plot of the mosque is 1.25 m.

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Other notable religious sites are Chakkamkulengara Temple which is located at approximately 600m from the alignment, and Hill Palace Museum an Archaeological museum is located at approximately 1.3Km from the Project alignment. There are no school or colleges or forest area along the RoW. One hospital, i.e. Verma hospital was observed along the RoW.

2.2.6 Technical Specifications ³

Geometrical design norms are based on international practices adopted for similar metro systems with standard gauge. Design speed is considered as 80 kmph. Horizontal and vertical alignment for elevated section are largely dictated by the geometry of the road.

Tracks are considered to be carried on viaduct superstructure supported by single piers, generally spaced at 25m c/c and located on the median of the road. At few locations special span of more than 25m is planned to avoid placing of piers/ portals in private land. Minimum track centre on the elevated section is kept as 4.2m. Extra clearance on curves, as required, will be applied on curves. Width of viaduct is considered as 10.m.

2.2.6.1 Viaduct

The super structure of entire corridor from Petta to Tripunithura will be consisting of I/U Girder carrying two tracks supported on single pier located on the median of the road. Width of the deck will 9.0 m and the piers will be elliptical of 1.2 m x 1.85 m size. Road clearance of 5.5 m will be ensured below the viaduct structure. The foundation shall be pile foundation at most of the locations. The precast items (Superstructure & Pier Cap) will be casted at Pre-Cast Yard at FACT from where it will be transported to site through custom made trailers. The erection of the superstructure is being done through high capacity cranes placed on ground.

2.2.6.2 Gauge

Standard Gauge (1435mm) is generally adopted for metro railways world-over. Kochi Metro Phase-I corridor from Aluva to Petta is being implemented with standard gauge. With the objective of uniformity, the Project is proposed to be on Standard Gauge (1435mm).

2.2.6.3 Track Structure

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

- 60 Kg Head Hardened (HH) 1080 grade rails for main line.
- 60 Kg 90 UTS (non HH) rail for depot.
- Ballastless track for elevated viaduct and underground section of tunnel.
- At grade ballasted track for stabling lines in depot.
- Fastening system conforming to "Performance criteria of fastening system for ballastless track on Metro Railways/MRTS System".
- Turnouts 1 in 9 with lead radius of 190m and speed potential of 30kmph on divergent track.
- Scissor Cross over (1 in 9) is provided for this corridor.
- Flash Butt welds.

2.2.6.4 Traction System

The 750V DC third rail system is being used on the phase-I corridor of Kochi Metro. Thus, to ensure consistency with the existing system, similar 750V DC third rail traction system is proposed for the Project.

2.2.6.5 Signalling and Train Control

Signalling & train control system for Kochi Metro Phase-IA and B is proposed for design headway of 90 seconds so as to meet sustained train operation at up to 2 minutes interval during peak hours. The proposed system shall be compatible with the existing Phase-I system for seamless operation &

³ KMRL, DPR-ALUVA- TRIPUNITHURA and SN Junction to TRIPUNITHURA

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maintenance. Therefore, these requirements of the metro are planned to be achieved by adopting a state of art communication-based train control system. This will enable running of optimum train services meeting traffic requirements in the most efficient and cost-effective way. The signalling & train control system will ensure:

- High level of safety with trains running at close headway ensuring continuous safe train separation.
- Eliminate accidents due to driver passing signal at danger by continuous speed monitoring and automatic application of brake in case of disregard of signal / warning by the driver
- Provide safety and enforces speed limit on section having permanent and temporary speed restrictions.
- Improve capacity with safer and smoother operations. Driver will have continuous display of target speed / distance to go status in metro cab enabling him to optimize the speed potential of the track section.
- Moving block feature shall provide enhancement of headway.
- Improve maintenance of signalling and telecommunication equipment's by monitoring system status of trackside and train born equipment's and enabling preventive maintenance.

2.2.6.6 Telecommunication

The telecommunication system acts as backbone for KMRL system and provides telecommunication services to meet operational and administrative requirements of metro network. The proposed system shall be compatible with the existing Kochi Metro Phase-I system for seamless operation & maintenance. The proposed telecom system and transmission media will have following systems:

- Optical Fibre Cable
- Telephone Exchange
- Mobile Radio Communication
- Public Address System
- Centralized Clock System
- Passenger Information System
- Close Circuit Television
- Central Voice Recording System (CVRS) and
- Access control system

2.2.6.7 Rolling Stock

Rolling stock for Kochi Metro has been selected based on the following criteria:

- Proven equipment with high reliability;
- Passenger safety features, including fire resistance;
- Energy efficiency;
- Light weight equipment and coach body;
- Optimized scheduled speed;
- Aesthetically pleasing interior and exterior;
- Low life cycle cost; and
- Flexibility to meet increase in traffic demand.

The controlling criteria are reliability, low energy consumption, light weight and high efficiency, leading to lower annualized cost of service. The coach would have high rate of acceleration and deceleration.

Keeping the above features in mind, 2.7 m wide stainless-steel light weight coaches are proposed for Kochi Metro, with length of 17.86 m for trailer coach and 18.00 m for motor coach (including couple buffers). Height of coach will be 3.9 m. Train length for 3 coach train will be 55.5 m. The axle load will be 13 Ton for which the structures will be designed.

Traction motors will be 180 KW and propulsion system will be 3-phase drive with variable voltage and variable frequency (VVVF) control. Trains will have regenerative braking system to save energy cost. Trains will be air-conditioned and provided with automatic door closing and opening system with 3

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wide doors per coach on each side. The trains will have passenger information and announcement system. The rolling stock will be provided with train protection and warning system to prevent driver passing the signals at danger. It is an accepted fact that 60-70% of accidents take place on account of human error. Adoption of this system will reduce the possibility of human error.

Coaches will have longitudinal seats with a seating capacity of 35 and 156 standees per motor coach and 44 seating and 174 standees per trailer coach, thus total dense crush capacity of 191 (MC) to 218 (TC), at 6 persons/sqm.

The rolling stock proposed shall have design speed of 90 kmph and maximum running speed of 80 kmph. Maximum acceleration and deceleration is 01.0m/s² and 1.1 m/s². During emergency braking deceleration shall be 1.3m/s². Average commercial speed will be 33 kmph with station dwelling time of 30 seconds.

2.2.7 Associated Facilities

2.2.7.1 Maintenance Depot at Muttom

KMRL have a well-established depot- cum- workshop at Muttom. This same depot will be used for Phase IA & IB. The depot is spread across a total of 23.605 hectares.

All the rakes will be serviced at depot cum workshop for the scheduled inspections, major schedules viz periodical overhaul (POH) and major unscheduled repairs at Muttom Depot. The depot houses Operation Control Centre (OCC), administrative building, maintenance facilities for civil work – track, buildings, water supply; electrical work – traction, electricity and magnetism (E&M); Signalling & Telecommunication, Automatic Fare Collection, etc. apart from necessary facilities viz stabling lines, scheduled inspection lines, workshop for overhaul, unscheduled maintenance will also include major repairs, wheel profiling, heavy interior/under frame/roof cleaning etc. for the rolling stock operational on the corridor. The Mutton depot is equipped with rooftop solar panels as well as a solar farm, with a capacity of 2719 kW.

Maintenance schedule is established for maintenance of the rolling stock and rakes. Checks will be at various levels and intervals. Daily night check and 72 hours check of the rolling stock will be carried out to check train condition & functioning. Train will be cleaned & mopped on daily basis. Detailed inspection of train will be carried out to check the functioning of the sub-system, under frames, replacement & topping up of oils & lubricant after every 15 days or coverage of 6000 km. Further detailed inspection of above tasks is carried out on completion of 18000 km or 45 days, 36,000 km or 90 days, 72,000 km or 180 days, 150,000 km or 360 days and 300,000 km or two years. All the sub-assemblies (electrical & mechanical) are checked thoroughly after covering 520000 km or 3.5 years.

During this maintenance, pneumatic valves & compressor will be over hauled. All the system & sub-systems will be brought to original conditions and replacement & rectification of the parts during the inspection. After every 7 years (1,040,000 km) all the sub-assemblies, bogies suspension system, traction motor, gear control equipment, air conditioning units will be dismantled or will be overhauled to bring them to normal condition. Similar inspections/maintenance will be carried out after completion of 1,560,000 km or 10.5 years and 2,250,000 km or 15 years. Changing of heavy item such as bogies, traction motor, axles, gear cases and axle boxes etc. will be under heavy repair work and will be carried out as required. All the trains will be washed after every 3 days through automatic washing plant provided at depot. It takes 10 minutes to clean the train. Heavy washing will be carried out at depot after every 30 days and it takes 2-3 hours.

2.2.7.2 FACT Casting Yard

For viaducts segmental pre-cast construction requires a casting yard. The casting yard has facilities 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. The casting yard is spread over an area of about 2.5 Ha. The site is enclosed by fencing on all four sides and manned by security guards, with entry being restricted. The FACT (Fertilisers and Chemicals Travancore) casting yard has already been established for Kochi Metro Phase I and its usage is continued for Phase I extension as well. The cast segment will be transported on trailers and launched in position through launching girders.

2.2.7.3 Stockyard and Labour Camp

For the proposed metro Phase I extension a material storage yard and labour colony has been set up at Irumpanam which is being used and maintained by KEC-CCECC. The storage area has facilities for storage of raw as well as surplus used materials from the construction site. The stockyard is spread over an area of approximately 1.2 hectares. The yard houses a labour camp with approximately 300 labours. There is also a training set up precisely for vertigo testing, for labours working at height. The site is enclosed by fencing on all four sides and manned by security guards, with entry being restricted.

2.2.8 Road Widening

Road widening is planned at location where sufficient RoW is not available for accommodating the traffic as well as construction activities for metro. Minimum distance desired between via ducts and properties is 3 m and width of the viaducts with track centre at 4.87 m c/c is 10.45 m. Thus, minimum RoW available for metro construction required is 16.45 m and for road widening to two lane traffic is 22 m. Other than this RoW is also required for movement of traffic during construction and operation phase. A road bridge exists at Chembakkara canal and a new bridge is also constructed parallel to the existing bridge to prevent the traffic congestion issues during metro construction. In some areas from ROB to Tripunithura station, Municipality already has plan to develop & expand the road so that section of land will be acquired by the municipality and metro can be constructed in that section after acquisition of land.

2.2.9 Improvement of Footpaths/ Walkways in Station Influence Zone

For smooth movement of pedestrians, all the footpaths in influence zone have been considered to be upgraded to desired level of comfort. Influence zone has been assumed as 1Km from the central line of the proposed metro station. Accordingly all the roads including main road where the metro alignment is proposed will be upgraded by provision of 1.5m wider footpaths on both sides for the roads having 10m-18m ROW and 2m wide footpath on both sides for the main road or the roads having 18m and more ROW for upto 1Km length from central line of the station. The length assumed for the upgradation in both sides of central line of proposed metro station is taken as 1km maximum or mid of the section whichever is less for main road as well as crossroads, which will be reviewed during execution stage. Typical cross section of footpath for estimate purpose has been assumed as shown in Figure 2-4 for estimate purpose. Detailed planning in regard to its integration with side drains and toe walls will be done at the execution stage.

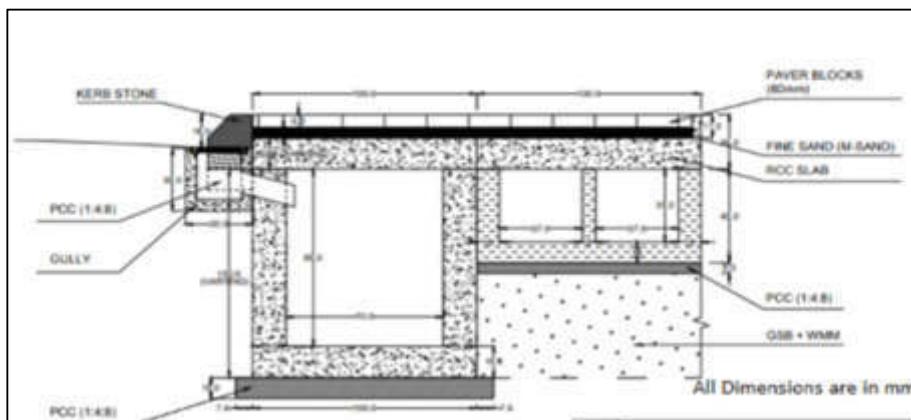


Figure 2-4: Typical section of footpath

2.3 Status of the Project

KMRL is working on piling of the viaduct from Petta to SN Junction. KEC International Ltd and CCECC as JV. is contracted by the KMRL for construction of the Project. So far, KMRL has achieved around 30 per cent physical construction progress on the stretch. During the AECOM team site visit the construction work was under progress along Petta to S N Junction Station area, which included viaduct work. As part of preparatory works for Kochi Metro project, KMRL is constructing an additional two-lane bridge on Chembakkara Canal.

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The Casting Yard and Labour Colony at Eloor which was used for Phase I of Metro Project, is being used for this Project also by the KEC International Ltd. Apart from this, there is Material Storage Yard and Labour Colony at Irumpanam which is being used by KEC-CCECC.

Government of Kerala (GoK) have issued Administrative sanctions for the extension for 206 cents for which requisition is under process. Additional Administrative sanctions is waited for 463.13 cents from GoK. A Social Impact Assessment would be carried out for the area to access the impacts before the process of land acquisition begins. At present detail design is under final stages, LOA has been issued to the EPC contractors (KEC – VNC JV), preliminary work and geotechnical investigation have started in the area.

2.4 Resource Requirement and Procurement

2.4.1 Land requirement and Procurement process

2.4.1.1 Land footprint

As the Project is going to be developed as elevated Metro through existing roads, majority of the land requirement for project is for viaduct, station structures, electric sub-stations, etc. As part of preparatory works, road Right of Way (RoW) widening and construction of 2 lane bridge on Champakkara Canal was undertaken by KMRL, as directed by Kerala State Government to manage traffic especially, during the construction phase.

The total land required for Vadakkekotta Metro Station in IA alignment and RoW widening of the entire IA and IB stretch is 1.1907 hectares. It falls under two villages, Nadama and Punithura in Ernakulam district of Kerala. The details are given in the table below.

Table 2-4: Land Required

<i>Land type</i>	<i>Area in hectares (IA station & RoW Widening)</i>	<i>Area in hectares (IB stations)</i>
Private	1.1802	0.8325
Government	0.0105	2.0062
Total	1.1907	2.8387

Source: (IA stations+ Road Widening) Information shared by KMRL, October 2020
(IB stations) Detailed Project Report, 2018

Land requirement for S N Junction and Thripunithura Station/Terminal is yet to be finalized and the land acquisition is yet to begin for the same.

The entire stretch of IA and IB is being acquired by a government led acquisition under Right to Fair Compensation and Transparency in Land Acquisition Rehabilitation and Resettlement Act, 2013 (RFCLARR, 2013) and the consequent Right to Fair Compensation and Transparency in Land Acquisition Rehabilitation and Resettlement (Kerala) Rules 2015. Acquisition for 1.1126 hectares out of 1.1907 hectares is complete. The details of land acquired so far are given in the Table 2-3 below.

Table 2-5: Land Acquired

<i>Land type</i>	<i>Area in hectares</i>
Private	1.0371
Government	0.0755
Total	1.1126

Source: Land Acquisition Authorities, Ernakulam, November 2020

Discussions with the Land Acquisition (LA) Authorities indicated that the land acquisition for RoW widening is completed and handed over to KMRL in December 2019. Land for Metro Stations at Vadakkekotta has been acquired, for S N Junction is in process, and land acquisition for Thripunithura is proposed. LA Authority plan to transfer the awards for completed land acquisition parcels to KMRL by December 2020.

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The status of acquisition as per information made available, is captured here.

- The stretch between Petta and SN Junction stations falls under Cochin Madurai National Highway 85 (former National Highway 49). Since, there is no acquisition of land required for the above-ground structures, KMRL shall provide an Intimation Letter to the National Highways Wing under PWD Kerala, before starting construction of the metro track and viaducts.
- Parcels of land required for expansion/widening of the National Highway 85 had been acquired in 2018 and 2019. Awards had been issued to all the project impacted entities and land has been transferred to KMRL as reported.
- For construction of the bridge over Champakara canal, land has been allotted by the Irrigation Division, Ernakulam.
- Land acquisition for Vadakkekota station (0.99ha) is complete and all awards are issued to respective impacted families.
- The land acquisition for S N Junction station (0.21ha) is in progress.
- Acquisition of land for Thripunithura station/terminal will begin after the land parcels are finalised.

It is understood that compensation and resettlement and rehabilitation (R&R) to all affected families for the road widening of IA and IB is disbursed. For the families affected by land acquisition for Vadakkekota the awards are issued, and compensation procedure is in progress. The exact status of disbursement to number of affected families is yet to be confirmed.

As reported by land acquisition team, the compensation disbursement and R&R implementation for families affected by land acquisition for S N Junction is yet to begin.

2.4.1.3 Team Involved in Acquisition

For Phase IA and IB, the land acquisition is being undertaken as per Right to Fair Compensation and Transparency in Land Acquisition and Resettlement and Rehabilitation (RFCTLARR) Act 2013. This being a government-led acquisition, as per RFCTLARR Act 2013 provisions, the team of District Collector, Deputy Collector, Tahsildars and officials from Land Revenue Departments are playing key roles and responsibilities of acquisition, compensation, and resettlement and rehabilitation (R&R). To provide support to the government authorities, KMRL has engaged third party consultants to facilitate the land acquisition process. The specific roles and responsibilities, relevant to the process of land acquisition for Phase IA and IB, are given in the Table 2-6.

Table 2-6: Land Acquisition Team

Key Responsibility	Persons Responsible
Land Acquisition	
<ul style="list-style-type: none"> • Identification of land • Hearing objections • Appointing SIA team 	<ul style="list-style-type: none"> • District Collector, Ernakulam • Land Acquisition Officer (LAO) (appointed for the project) • Tahsildar, Kakkadan
Permissions	
<ul style="list-style-type: none"> • Construction of elevated metro track, viaducts above NH85 • Construction of bridge over Chembakkara canal • Tree cutting • Construction of elevated metro track, viaducts above railway track 	<ul style="list-style-type: none"> • National Highways Wing, Public Works Department (PWD), Kerala • Irrigation Division, Ernakulam • District Forest Officer, Ernakulam
Social Impact Assessment study preparation	
Undertaking Social Impact Assessment (SIA) study	Rajagiri Outreach (third party appointed by District Collector)

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Social Impact Assessment study finalization

Review and Approval of the SIA report	Expert Group formed by District Collector
Valuation of assets	Third party appointed by KMRL

Resettlement and Rehabilitation

- R&R Scheme preparation
- Census survey of affected families
- R&R Scheme approval
- R&R implementation
- R&R Commissioner (appointed for the Project)
- R&R Administrator

Financial Support

- Land acquisition cost KMRL
- Compensation amount for affected families
- R&R implementation amount

Facilitation

Assist the LAO in identifying the land affected by KMRL
families

Source: KMRL, November 2020

2.4.1.4 Process of acquisition

The process followed in this government led land acquisition is in accordance to the RFCTLARR Act 2013. The key steps involved are as follows:

- Proposal for land acquisition was submitted to District Collector, Ernakulam by KMRL;
- SIA Studies were conducted for road widening (Nov 2017) and Vadakkekotta station (Nov 2019);
- Public hearing for SIA on road widening (Nov 2017) and for SIA on Vadakkekotta station (Nov 2019) followed by incorporation of suggestions and objections into the SIA reports;
- Expert Group and DC approved the SIA studies;
- Preliminary Notification about the land to be acquired was published;
- Objections on the identified land were invited and heard on the selection of land for the project;
- R&R Scheme was prepared and approved by the R&R Administrator and R&R Commissioner respectively;
- R&R Scheme was published in Official Gazette;
- Awards were issued to all affected families;
- Compensation amount was disbursed to all affected families;
- Provisions of R&R Scheme were implemented.

Note: The timelines of each of these key steps for Phase IA and IB are awaited to be shared with AECOM.

2.4.1.5 Affected Families

The project affected families by the road widening and Vadakkekotta are as follows:

Table 2-7 Project Affected Families/Persons

Sr N	Project affected families (identified in the SIA)	Families affected by Road widening of IA and IB	Families affected by Vadakkekotta station
1.	Total families (persons)	366 (1,245)	58
2.	Titleholders	211	30
3.	Non-titleholders	155	28
4.	Land losers (no property loss)	07	Not known

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5. Residential property owners	51	01
6. Commercial property owners	03	01
7. Residential and Commercial property owners	08	01
8. Tenants*	02	01
9. Religious properties	07	

Note: This comprises of residential, commercial or residential + commercial properties.

Source: SIA Reports 2017 and 2019

Out of these, 12 families are physically displaced due to land acquisition and 71 families are economically displaced for road widening. Information about the exact number of physically and economically displaced families due to land acquisition for Vadakkekotta station and the project affected families due to land acquisition for S N Junction was not available during AECOM's assessment. Families affected by Thripunithura station were yet to be identified during AECOM's assessment.

2.4.2 Human Resources

The project is likely to be completed in a period of about 3 years. During this period manpower will be needed to take part in various activities. Contractual workforce from KEC-CCECC JV are currently employed for construction of the Kochi Metro Phase I extension between Petta and Vadakkekotta stations and the bridge over Champaraka canal. KEC-CCECC had engaged nearly 350 workers at the time of commencement of construction activities for the IA section. As of November 2020, the requirement has increased up to 500 workers during peak construction phase. There are only 2-3 females in the total workforce, who have been engaged as traffic marshals. The workforce requirement is contingent to the construction schedule and timelines.

During the operations phase, KMRL shall require human resources for facility management services that include ticketing, customer care, housekeeping, security, and gardening. This requirement is estimated to range between 100-200 persons. Presently for Phase I metro, KMRL has appointed Kudumbashree Facility Management Centre for all the services apart from security. The same is likely to be continued for Phase IA and IB as well. For operation and maintenance, existing staff of Phase I will be likely involved.

2.4.3 Water Requirement

Construction Phase

Water requirement during construction phase will for construction labour, construction activity and batching plants. Two labour camps have been set up for the project at Irumpanam Stock yard and Eloor, FACT casting yard. It is estimated that app. 500 employee/labour are employed for construction of Phase I Extension. The water requirement at camp will be for activities such as drinking, cooking, personal washing, washing clothes etc, and hence a total of 55 KLD considering 500 persons @ 110 Lpcd (In accordance with the WHO "[Hierarchy of water requirements](#)").

Water requirement for construction purpose & at casting yards is approximately 60 KLD⁴. As per the KEC-CCECC representative's tanker water is used for the construction and domestic purposes. The drinking water is sourced through packaged tankers. Projected water demands are summarised in Table 2-8.

Table 2-8: Projected Water Requirement During Construction

S. No	Location	Activity	Projected Water Requirement Per Day (KLD)
1.	Civil Work		60

⁴ EIA for Kochi Metro Rail Phase I Extension "Petta to Tripunithura Terminal"

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S. No	Location	Activity	Projected Water Requirement Per Day (KLD)
2.	FACT casting Yard	Curing at casting Yard	
3.	Labour Camp	Drinking Purpose: 500 persons @ 10 lit per person per day	5
		Cooking: 500 persons @ 20 lit per person per day	10
		Personal washing: 500 persons @ 30 lit per person per day	15
		Washing clothes: 500 persons @ 40 lit per person per day	20
		Misc.: 500 persons @ 10 lit per person per day	5
		Total	55
Total Water Requirement (1+2+3)			115

Operation Phase

Water requirement during operation phase will met through ground water as per DPR. Permission shall be obtained from Groundwater Department (GoK) prior to extraction of ground water. Details of water requirement during the operation phase are given in Table 2-9.

Table 2-9: Projected Water Requirement During Operation⁵

S. No	Water Usage Location	Water Demand (KLD)
1.	At stations for drinking Purpose	18
2.	For other usage like toilets, cleaning etc.	90
Total Water Requirement-Operation Phase		108

Water requirement at Depot

Water supply will be required for different purposes in the depot which will be taken from borewell/ Municipal water supply. The water requirement for train washing purpose will be 600 litres per day. About 15 KLD of fresh water will be required at Depot for different uses. Permission shall be obtained from Groundwater Department (GoK). The Muttom depot have an STP/ETP. The treated wastewater would be recycled and used for domestic purposes and other water requirement for horticulture, flushing urinals/closet.

2.4.4 Power Supply⁶

The power requirements of a metro system are determined by peak-hour demands of power for traction and auxiliary applications. The broad estimation of auxiliary and traction power demand for the corridor has been made based on the following assumptions: -

- Train operation with 3 car rake at peak period headway of 90 seconds.
- Specific energy consumption of rolling stock – 65 KWh / 1000 GTKM
- Elevated/at grade station load – initially 200KW, which will increase to 250 KW in the year 2033 and 300 kW in 2043/2048
- Underground station load/ Depot auxiliary load - initially 2000 KW, which will increase to 2500 KW in the year 2031.

The annual energy consumption for Petta – S. N. Junction section is assessed to be about 3.65 million units in initial year which will increase to about 4.21 million units by horizon year 2031. The annual energy consumption for the proposed S. N. Junction to Tripunithura section of Kochi Metro Phase-IB is about 43 million units by the year 2030.

⁵ EIA for Kochi Metro Rail Phase I Extension “Petta to Tripunithura Terminal”

⁶ FEASIBILITY STUDY & DPR FOR KOCHI METRO PHASE - IB

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The high voltage power supply network of Kochi has 220kV, 110kV and 66kV network to cater to various types of demand in vicinity of the proposed corridor. Keeping in view the reliability requirements, it is proposed to avail power supply for traction as well as auxiliary services from the Thaikodam grid sub-stations of KSEB at 110 kV voltage level through cable feeders for the proposed corridors which is about 0.2km from the feeding zone.

In the unlikely event of simultaneous tripping of all the RSSs or grid failure, the power supply to stations as well as to trains will be interrupted. It is therefore proposed to provide standby DG set of 160 KVA capacity at Thripunithura to cater to the following essential services:

- Lift operation
- Essential lighting
- Signalling & telecommunications
- Firefighting system
- Fare collection system

Silent type of DG sets, which have low noise levels and do not require separate room for installation, are proposed. In addition, UPS with adequate power backup are proposed for the very essential lighting load.

To minimize the electrical load requirement of the project, entire electrical system is designed as per Energy Conservation Building Code (ECBC) and international recommendation. Following measures are considered for energy conservation during designing:

- Modern rolling stock with 3 phase VVVF drive and light weight stainless steel coaches, which has the benefits of low specific energy consumption and almost unity power factor.
- Rolling stock has regeneration features and it is expected that 30% of total traction energy will be regenerated and fed back to 750V dc third rail to be consumed by nearby trains
- Effective utilization of natural light is proposed. In addition, the lighting system of the stations will be provided with different circuits (33%, 66% & 100%) and the relevant circuits can be switched on based on the requirements (day or night, operation or maintenance hours etc).
- Machine-roomless type lifts with gearless drive have been proposed with 3 phase VVVF drive. These lifts are highly energy efficient.
- The proposed heavy-duty public service escalators will be provided with 3 phase VVVF drive which gives energy efficiency & improved power factor.
- Further, the escalators will be provided with infra-red sensors to automatically reduce the speed (to idling speed) when not being used by passengers.
- The latest state of art and energy efficient electrical equipment (e.g. transformers, motors, light fittings etc) has been incorporated in the system design.
- Efficient energy management is possible with proposed modern SCADA system by way of maximum demand (MD) and power factor control.
- Solar power plant may be installed at station to produce electricity which may meet the energy requirement of the station.

2.5 Waste Generation

2.5.1 Wastewater

The construction works for the development of project will entail generation of wastewater from domestic use through workers, drilling and other civil work, curing at casting yard and other industrial wastewater from batching plant, etc. The slurry waste or other liquid waste generated during construction phase needs to be disposed off by the contractor at a location approved by KMRL.

Wastewater Generated at Labour Camp

Approximately 44 KLD of domestic sewage from 500 labours in labour camp sites would be generated. Septic tanks and soak pits have been provided at labour camps.

Operation Phase

During operation phase, wastewater will be generated due to workers as well as passengers which will be disposed with the help of local municipal wastewater handling system / sewer lines. The treated wastewater needs to be tested for Inland Water Discharge Standard before releasing into water body, if required. As far as possible treated wastewater should be recycled to use at station horticulture / flushing, etc.

Wastewater Generated at Depot

The wastewater to be generated at the depot due to maintenance of coaches from the Project is expected to be treated in exiting ETP & STP at the Muttom Depot. The treated wastewater shall be recycled for horticulture work of the depot. About 12 KLD of treated wastewater will be used for horticulture and flushing purposes.

Storm Water

Storm water drainage system is proposed to be provided at the stations to channelize the storm water. Storm water from the station areas will be collected. This collected storm water shall be recharged into the ground through rainwater harvesting pits. Storm water collection & harvesting system shall also be provided at viaduct. One Rainwater collection and recharge pits shall be provided per 500 m of viaduct. Thus total 6 number of rainwater harvesting (RWH) pits shall be provided for viaduct and 3 for stations. RWH pits of 60 cum shall be provided for viaducts whereas RWH pits of 50 cum shall be provided for station buildings.

2.5.2 Solid Waste⁷

Construction Phase

Waste generated during construction phase includes the left-over concrete, timber, broken bricks, tiles, glass, metal rods and bars, used cement bags, rags, redundant machinery & tools, storage containers, plastic bags and containers, metal containers, Polymer Mud etc. The waste generated during construction phase is majorly recyclable and reusable. Entire waste will be segregated on time to time and will be disposed off through Metal Scrap Trade Corporation Limited (MSTC). Project development also involves demolition of various structures which are to be acquired. Demolition debris shall be collected and segregated in the reusable and reject fraction. Reusable fraction shall be stored in covered condition and reject fraction shall be disposed through the authorized vendors.

There will be generation of muck during excavation of soil for construction of foundation for the pillars and construction of entry-exit of stations. Total muck to be generated due to excavation (assuming 110 piers, excavation depth 8.5 m; width 2 m; and length 2 m and 7 number of entry exits for 3 stations having width 5 m, length 10 m and depth 3 m) will be approx. 4800 cum out of which 120 cum is topsoil (15 cm depth). Topsoil will be kept aside for undertaking compensatory plantation works. Considering swell factor of 40%, excavated muck other than topsoil will be 6552 cum. Most of the soil will be filled back (~70%) after construction of piers and entry/exit and remaining (1960 cum) can be used for road widening and construction purpose if feasible. Surplus can be disposed at designated construction and demolition waste sites of Kochi Municipal Corporation. A Brahmapuram Solid Waste Processing Plant located at Bhramanpura about 4.36Km from the site, could be considered for disposal of the surplus construction and demolition waste. No construction labour hutments shall be located at the project site.

The solid waste generated from labour accommodation would be approximately 125 kg/day at the rate of 0.25 kg/day per person. The waste to be generated from labour accommodation will required to be collected, segregated, recycled and disposed off in accordance to the Solid Waste Management Rules, 2016. Wet waste and other recyclable waste will be collected in two color bins. Wet waste will be disposed off through local agencies in the area and recyclable waste will be sold to authorized vendors.

Operation Phase

⁷ EIA for Kochi Metro Rail Phase I Extension "Petta to Tripunithura Terminal"

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During operation phase, major solid waste to be generated at stations will comprise of the paper, packaging waste, floor sweeping and small quantity of other waste which includes plastic, food waste, etc. The recyclable waste like paper will be sold to the recyclers. Remaining waste like floor sweepings and other waste will be disposed off through local agencies in the area on daily basis.

Expected number of staff (skilled and unskilled) at all the three metro stations would approximately be 150 and amount of the waste generated is estimated at the rate of 0.25 kg/day is 38 kg/day. The stations where the commercial areas are planned or where small shops are provided, waste generated will include plastic, packaging waste, food waste etc. Store owners should ensure that the waste is disposed off through the local agencies in the area on daily basis and no waste will be dumped on road or other area.

2.5.3 Hazardous Waste

During construction phase, hazardous waste such as used oil from diesel generator (DG) sets, oil-soaked cotton, oil lined containers, paints drums, etc. will be generated at the site. The hazardous waste is being disposed off by contractor through a Kerala state Pollution Control Board (KSPCB) authorized hazardous waste recycler (CEEJEE Lubricants).

During operation phase 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, spend solvents, etc.

According to the DPR, this will be disposed off through a Kerala state Pollution Control Board (KSPCB) authorized hazardous waste recycler (CEEJEE Lubricants).

Operation Phase

During operation phase, used oil and other hazardous waste will be sold periodically to authorize dealers (M/s Excel Petrochemicals Koonamthai, Kochi is authorized dealer for hazardous waste management & handling in Kochi).

2.6 Implementation Schedule

In continuation to Phase I Government approval has been received for 3.2km stretch from Petta-Tripunithura Station for which civil construction began in December 2019. the first Precast Piercap in the stretch was launched in June 2020 and the girders for Panamkutty Bridge launched on 30/06/2020. KMRL has achieved 30 per cent physical progress on the Phase IA stretch and is estimated to complete the stretch by November 2021. As reported by KMRL, both Phase 1A and Phase 1 B are expected to be completed in March 2022 and March 2023, respectively.

3. Applicable Policy, Legal and Administrative Framework and Standards

This section highlights the environmental and social regulations applicable to the Project. The section broadly focuses on the institutional framework, national administrative/ regulatory requirements, applicable environment, health and safety and social legislative requirements, Strategies and Operations Manuals, ADB Safeguard Policies and IFC Performance Standards, relevant to the proposed project.

3.1 Applicable Indian Legal Requirements and Enforcement Authorities

3.1.1 Environment Clearance

The Environmental Impact Assessment (EIA) is a management tool to minimize adverse impacts of developmental projects on the environment and to achieve sustainable development through timely, adequate, corrective and protective mitigation measures. As per the current regulations of Government of India, Railway projects do not require conducting Environmental Impact Assessment (EIA) studies for obtaining Environmental Clearance (EC) under EIA Notification 2006.

3.1.2 Costal Regulation Zone Clearance (CRZ)

Ministry of Environment, Forest And Climate Change (MoEF&CC) has developed the Costal Regulation Zone regulations with intent to conserve and protect the unique environment of coastal stretches and marine areas, besides livelihood security to the fisher communities and other local communities in the coastal areas and to promote sustainable development.

As per Costal Regulation Zone Notification 18th January 2019, the proposed project area falls under the CRZ area at crossing over the Champaraka canal as well as a small section just before the proposed Vadakkekotta station. As per CRZ categorization the proposed project will likely come under CRZ II categorization. As per the notification under CRZ II construction activities are permitted, however with prior CRZ clearance from the state CRZ committee in this case the Kerala Coastal Zone Management Authority. As per information available to AECOM during this assessment, no CRZ clearance was available for review. Figure 3-1 illustrates a CRZ map from the [Coastal Zone Management Plan of Kerala](#) along with the alignment falling under CRZ II.

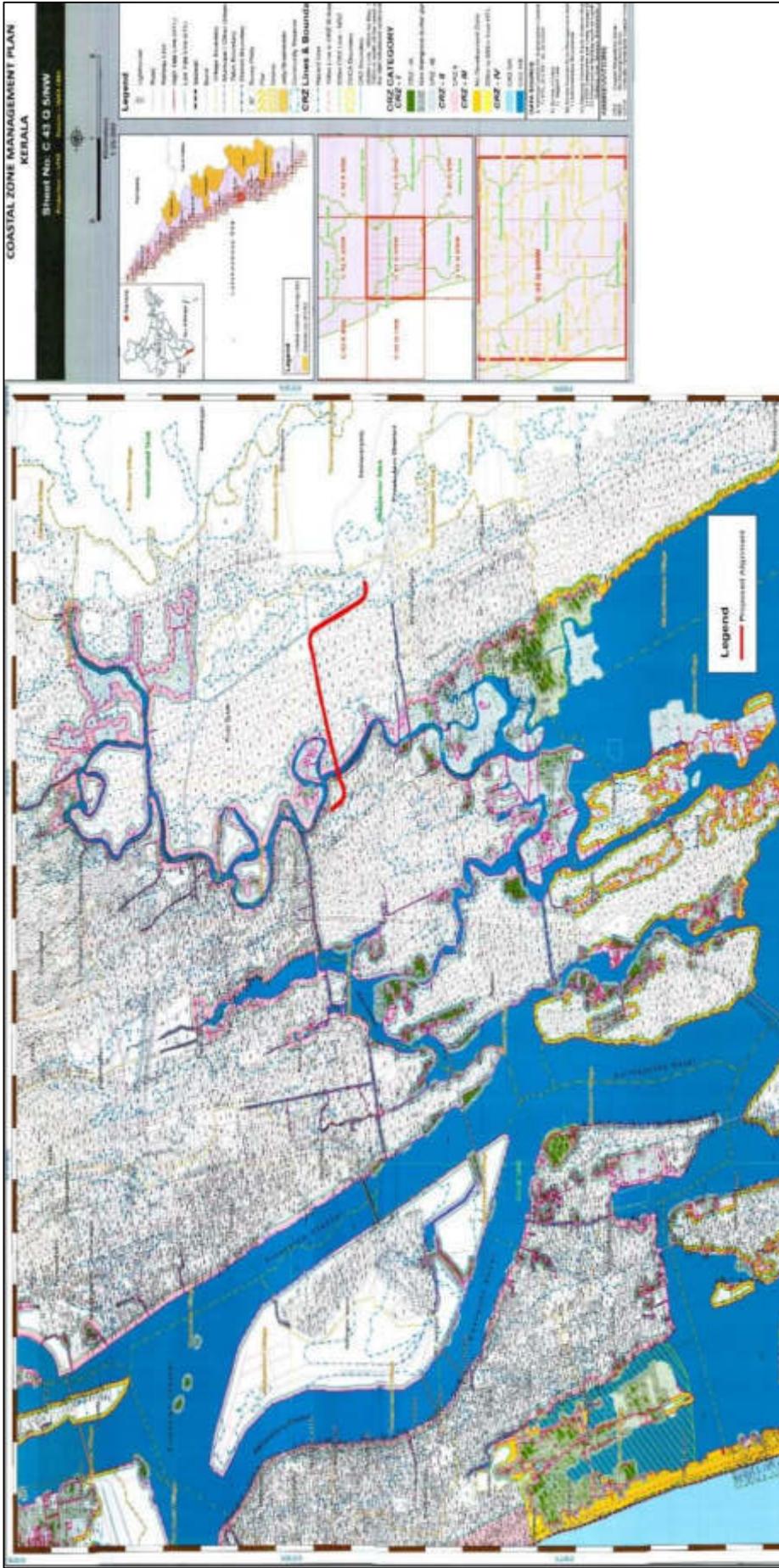


Figure 3-1: CRZ map of Kerala⁸

(Disclaimer: This is an indicative map and not CRZ map authorized by any government agency/institution. AECOM have superimposed project alignment on available CRZ map (source: http://keralaczma.gov.in/hearing/records/trivandrum/KL_32.pdf). The actual CRZ mapping for project might vary based on site conditions)

⁸ http://keralaczma.gov.in/hearing/records/trivandrum/KL_32.pdf

3.2 Applicable Environment and Social Laws and Regulations

All the applicable Policies, Rules and Regulations by Government of India (GoI), Government of Kerala (GoK), Indian Railways along with rules, policies and Regulations of Environment, Health and Safety related to the project are listed.

Table 3-1 summarizes the key regulations that are relevant to the project across its lifecycle. This table should be used to update/develop a comprehensive legal register for the Project.

Table 3-1: Applicable Environment and Social Laws and Regulations

Regulation	Enforcement Authority	Summary	Applicability	Required Action
Railways (Amendment) Act, 2008	Ministry of Railways	Indian Railways (IR) is a governmental entity under the Ministry of Railways that operates India's national railway system.	Applicable.	
Environmental (Protection) Act, 1986 and associated rules and notifications under the Act	State Pollution control Board	Section 3(1) of the Act empowers the Centre to "take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution". It also authorizes the government to make rules on any aspect related to environmental protection. The Act also provides that no industries can discharge any solid, liquid or gaseous substances beyond the permissible limits as laid down by the Central Government on its behalf,	Applicable Various environmental acts & rules are prepared under this act which will be applicable to various activities of project.	Client & contactors will have to ensure that project adheres to the various clauses laid down in the Act.
EIA Notification 2006 (as amended)	Ministry of Environment and Climate Change (MoEF&CC)	The Environmental Impact Assessment (EIA) is a management tool to minimize adverse impacts of developmental projects on the environment and to achieve sustainable development through timely, adequate, corrective and protective mitigation measures. The Ministry of Environment, Forests and Climate Change (MoEF&CC) uses Environmental Impact Assessment Notification 2006 as a major tool for minimizing the adverse impact of rapid industrialization on environment and for	Not Applicable As per the current regulations of Government of India, Railway projects do not require conducting Environmental Impact Assessment (EIA) studies for obtaining Environmental Clearance (EC) under EIA Notification 2006 ⁹ .	

⁹ <https://www.thehindu.com/news/national/SC-stays-NGT-order-asking-Railway-Metro-to-seek-EC-for-projects/article14436256.ece>

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Regulation	Enforcement Authority	Summary	Applicability	Required Action
Coastal Regulation Zone (CRZ) Notification, 2019	Kerala Coastal Zone Management Authority (KCZMA)	reversing those trends which may lead to climate change in long run.	Applicable Ministry of Environment, Forest and Climate Change (MoEF&CC) had developed these regulations with intent to conserve and protect the unique environment of coastal stretches and marine areas, besides livelihood security to the fisher communities and other local communities in the coastal areas and to promote sustainable development	As per the Coastal Zone Management Plan Of Kerala Ernakulam District, it was observed the project would come under the preview of the Coastal Regulation Zone as per the Coastal Regulation Zone Notification, 2019.
Forest (Conservation) Act, 1980 (as amended) Forest Conservation Rules, 2003 (as amended)	The Wildlife (Protection) Act, 1972 (as amended)	The Forest Conservation Act and Rules mandate projects requiring diversion of forest land for non-forest purposes to seek Forest Clearance from the Ministry of Environment and Forests.	Not Applicable Project alignment does not pass through any forest land and thus forest land will not be used for proposed project.	Not Applicable The Government of India enacted Wildlife (Protection) Act 1972 with the objective of effectively protecting the wildlife of this country and to control poaching, smuggling and illegal trade in wildlife and its derivatives. The Act was amended in January 2003 and punishment and penalty for offences under the Act have been made more stringent.
The Kerala Restriction on Cutting and Destruction of Valuable Trees Rules, 1974	Tree Officer, State Government District Tree Authority	This Act makes provision for regulating the felling of certain trees in the State of Kerala, for the purpose of the preservation thereof, and for the protection of the soil against erosion. There are restrictions on felling of 15 species of trees which are specified in the Schedule of the said Act, (called as "Scheduled Trees") without the previous permission of the concerned authority.	Applicable Cutting of trees is envisioned at some sites during the implementation of the project.	Client & contractors should ensure that permission from relevant authorities is taken before tree cutting for any project activity along with necessary compensatory afforestation in accordance to the regulation.

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Regulation	Enforcement Authority	Summary	Applicability	Required Action
The Water (Prevention and Control of Pollution) Act, 1974 (as amended)	Kerala State Pollution Control Board. (KPCB)	<p>The Act vests regulatory authority on the State Pollution Control Boards and empowers them to establish and enforce effluent standards for industries discharging effluents into water bodies. A Central Board performs the same function for Union Territories.</p> <p>As per Section 25, the Board controls industrial effluent and sewage discharges by approving, rejecting or conditioning applications for "Consent to Discharge" without which no person can establish or run an industry involving effluent discharges into any stream, sewer or land.</p>	Applicable Project activities will lead to generation of wastewater from construction activities, domestic wastewater due to workers, etc.	<p>KMRL should ensure that the Consent to Establish (CTE) & Consent to Operate (CTO) is received from State Pollution Control Board for the Kochi Metro Maintenance Depot at Muttom Depot and all Station (as per B-29016/ROGW/IPC-VII/2020-21/ dated 30th April 2020.) prior to commencement of project activity.</p> <p>Wastewater generated from the project activities should be treated and disposed as per applicable discharge standards and CTE & CTO norms.</p>
The Kerala Ground Water (Control and Regulation) Act, 2002	Groundwater Department (GoK)	<p>The Act provides for the conservation of ground water and for the regulation and control of its extraction and use in the State of Kerala.</p>	Applicable The project indulges in abstraction of groundwater as a source of water for operation of Muttom maintenance Depot.	<p>KMRL should ensure, NOC from Groundwater Department is undertaken for the abstraction of ground water.</p>
Air (Prevention and Control of Pollution) Act, 1981 (as amended)	Kerala State Pollution Control Board. (KPCB)	<p>Section 21 of the Air Act specifies that no person shall without the consent of the State Board establish or operate any industrial plant in any air pollution control area. It is also provided in the statute that industrial units cannot discharge any pollutants into the air in excess of the standards of the standards prescribed by the State Pollution Control Boards. The States are required to prescribe such "Emission Standards" for different categories of industries and automobiles after consulting the Central Board and monitoring its Ambient Air Quality.</p>	Applicable Project activities will lead to generation of air emissions from various construction / project activities, operation of DG sets, etc.	<p>Client and contractors should ensure that the Consent to Establish (CTE) & Consent to Operate (CTO) is received from State Pollution Control Board for the Kochi Metro Maintenance Depot at Muttom Depot and all Station (as per B-29016/ROGW/IPC-VII/2020-21/ dated 30th April 2020.) prior to commencement of project activity.</p> <p>All emissions generated from the project activities should be within applicable emission standards, National Ambient Air Quality</p>

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Regulation	Enforcement Authority	Summary	Applicability	Required Action
The Noise Pollution (Regulation and Control) Rules, 2000 (as amended)	Kerala State Pollution Control Board. (KPCB)	Boards may close down a defaulting unit or stop its supply of electricity or water.	Applicable The Noise Rules were notified in 2000 under the Environment (Protection) Act, 1986. These rules aim at regulating and controlling the noise producing and generating sources with the objective of maintaining the ambient air quality standards in respect of noise.	Standards (NAAQS) and CTE & CTO norms, as applicable. Further, the contractor should ensure that all the vehicles employed for project execution possess a valid Pollution Under Control (PUC) certificate.
Control of Noise from Diesel Generator (DG) sets, 2002 (as amended)	Kerala State Pollution Control Board. (KPCB)	This document lays down the applicability and requirements, certification system and test, procedures, for compliance with noise limits for new diesel generator sets.	Applicable As per section 3.2 of the Govt. Of India notification GSR 371 (E), dated 17.05.2002 and its amendments, at serial number 94, every manufacturer or assembler or importer (hereinafter referred to as 'manufacturer') of DG sets (hereinafter referred to as product) to which these regulations apply must have valid certificates of Type Approval and also valid certificates of Conformity of Production for each year, for all the product models being manufactured or assembled or	Client and contractors should ensure that National Ambient Air Quality Standards in respect to Noise (NAAQSN) are not exceeded. All machineries and equipment's should be well maintained. DG sets should be provided with a acoustic enclosure comply relevant norms related to noise.

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Regulation	Enforcement Authority	Summary	Applicability	Required Action
Metro Rail Transit System, Guidelines for Noise and Vibrations, RDSO, Ministry of Railways, September 2015	This document lays guidelines for noise reference levels, vibration impact criteria for detailed analysis, noise and vibration mitigation measures, and ways of reducing excessive noise and vibration caused by metro railway projects, hereafter referred as rail transit systems/projects	Applicable	imported from 1st January 2005 with the noise limit specified ¹⁰	The client should follow Recommended norms for Noise and vibration for metro railway in India along with Vibration Screening procedure and Vibration analysis.
Solid Waste Management Rules, 2016	Kerala State Pollution Control Board. (KPCB)	The rules require waste generator to segregate and store the waste generated in three separate streams namely biodegradable, non-biodegradable and domestic hazardous wastes in suitable bins and handover segregated wastes to authorised waste pickers or waste collectors.	Applicable During construction phase, solid waste of proposed project may be generated from excavation of soil, scraps metal, construction debris, etc. during operation phase solid waste may be generated from station areas, maintenance activities, depot area, etc.	Client and contractors should ensure that solid waste is segregated, stored and disposed as per the regulations laid down under the Solid Waste Management Rules, 2016.
Plastic Waste Management (Amendment) Rules, 2018	Kerala State Pollution Control Board. (KPCB)	To address the issue of plastic waste minimization, source segregation, recycling, involving waste pickers, recyclers and waste processors in collection of plastic waste, Ministry of Environment, Forest and Climate Change has notified Plastic Waste Management (Amendment) Rules, 2018	Applicable Generation of plastic waste is envisaged for the proposed project like package material, cartons, etc for construction material or material for maintenance activities, etc.	Client & Contractors should ensure minimization of generation of plastic waste, segregation of the same at source and segregated storage. Segregated waste should be handed over to urban local body or gram panchayat or agencies appointed by them or registered waste pickers', registered recyclers or waste collection agencies.
E-Waste Management Rules, 2016 (as amended)	Kerala State Pollution Control Board. (KPCB)	These rules shall apply to every manufacturer, producer, consumer, bulk consumer, collection centres, dealers, e-retailer, refurbished, dismantler and recycler involved in manufacture, sale, transfer, purchase, collection, storage and processing of e-waste or electrical and electronic equipment listed in Schedule I of this regulation	Applicable if e-waste from electrical and electronic equipment listed in Schedule I of this regulation are generated during project	Client and contractor should ensure that e-waste generated by them is channelized through collection centre or dealer of authorised producer or dismantler or recycler or through the designated take back service

¹⁰ <https://cpccb.nic.in/Diesel-Noise/>

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Regulation	Enforcement Authority	Summary	Applicability	Required Action
Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 (as amended)	Kerala State Pollution Control Board. (KPCB)	These rules aim at providing control for the generation, collection, treatment, transport, import storage and disposal of hazardous wastes. The principle objective of this regulation is to establish a control mechanism for the management of hazardous waste.	Applicable if hazardous waste from categories as mentioned in this regulation (Schedule I, II & III) are generated during project construction, operation, maintenance activities, etc. A letter from GoI Ministry of Railway Board via letter number 2007/RS(S)/709/10 dated 09.12.2013 has advised Railways/PUs to follow the rules ¹¹ .	Client and contractor should ensure that hazardous wastes shall be collected, stored, transported and disposed off the hazardous waste as per the rules laid down under Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 (as amended) It should be ensured that the hazardous waste be sent or sold to an authorised user or shall be disposed of in an authorised disposal facility.
Batteries (Management and Handling) Amendment Rules, 2010 (as amended)	Kerala State Pollution Control Board. (KPCB)	These rules shall apply to every manufacturer, importer, re-conditioner, assembler, dealer, recycler, auctioneer, consumer, and bulk consumer involved in manufacture, processing, sale, purchase and use of batteries or components thereof.	Applicable if e-waste is generated during project construction, operation, maintenance activities, etc. A letter from GoI Ministry of Railway Board via letter number 2007/RS(S)/709/10 dated 09.12.2013 has advised Railways/PUs to follow the rules ¹² .	Client and contractor should ensure that battery waste is disposed of with help of the dealer, manufacturer, importer, assembler, registered recycler, reconditioned or at the designated collection centres.
Construction and Demolition Waste Management Rules, 2016	Kerala Municipal Council	Rules provide guidelines to handling and disposal of waste resulting from construction, re-modelling, repair and demolition of any civil structure of individual or organisation or authority who generates construction and demolition waste such as building materials, debris, rubble.	Applicable Construction / demolition waste is envisaged to be generated during project construction, operation, maintenance activities, etc.	Client & Contractors should ensure that construction and demolition waste is stored within the premise or get the waste deposited at collection centre so made by the local body or handover it to the authorized processing facilities of construction and demolition waste.

¹¹ http://indianrailways.gov.in/railway/board/uploads/directorate/stores/downloads/Scrap_Circulars/9_09_12_2013.pdf
¹² http://indianrailways.gov.in/railway/board/uploads/directorate/stores/downloads/Scrap_Circulars/9_09_12_2013.pdf

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Regulation	Enforcement Authority	Summary	Applicability	Required Action
License under Factories Act, 1948	Director Industrial Safety and Health (DISH)	<p>Under the Factories Act, "factory" means any premises:</p> <p>Where ten or more than ten workers are working or were working on any day of the preceding twelve months, and in any part of which a manufacturing power is being carried on with the aid of power, or is ordinarily so carried on, or Where twenty or more than twenty workers are working or were working on any day of the preceding twelve months, and in any part of which a manufacturing process is being carried on without the aid of power or is ordinarily so carried on.</p>	Applicable As per the Factories Act Factory license is required as 'factory' means any premises having ten or more workers involved in a manufacturing process 'Applicable for the Casting Yard which would be involved in manufacturing of precast Viaducts with more than 10 workers	<p>It should be ensured that there is no littering or deposition of construction and demolition waste to prevent obstruction to the traffic or the public or drains.</p> <p>As per the section 6 of The Factories Act, 194, client would have to obtain registration from the State Government or Chief Inspectorate of Factories, Kerala if 10 or more workers are engaged, triggering the applicability of the Factories Act.</p>
The Petroleum Rules 1976, as amended in March 2002.	Petroleum and Explosives Safety Organisation (PESO)	<p>As per Section 3 of The Petroleum Act 1934 and Rule 116 of The Petroleum Rules 1976, client will be required to obtain a license from PESO, if the quantity of the fuel stored exceeds two thousand and five hundred litres and/or is stored in a receptacle exceeding one thousand litres in capacity.</p>	Applicable As there will be storage of Diesel at site for operation of generators during construction phase.	Client should ensure to obtain a license from PESO, if the quantity of the fuel stored exceeds two thousand and five hundred litres and/or is stored in a receptacle exceeding one thousand litres in capacity.
Gas Cylinder rules, 2016	Petroleum and Explosives Safety Organisation (PESO)	<p>The PESO is under the Department of Industrial Policy & Promotion, Ministry of Commerce and Industry, Government of India. The Chief Controller of explosives is responsible to deal with provisions of: The Explosive Act, 1884 and Rules, 2008, The Petroleum Act, 1934 and the Rules 2002, The Static and Mobile pressure vessels (Unfired) Rules, 2016 and amended 2018, and Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 and amendment 2000.</p> <p>The site will store a small quantity of fuel during construction phase. However, in case fuel storage exceeds the limit as stipulated in the Act, the project is required to obtain a license from PESO.</p>	Applicable when: <ul style="list-style-type: none"> The total number of cylinders containing any flammable and non-toxic gas does exceed twenty-five or the total weight of gas does not exceed 200 kg, whichever is less, at a time. Any non-flammable non-toxic gas when the total number of such cylinders does exceed two hundred at a time; <p>any toxic gas when the total quantity of such cylinders does not exceed five at a time</p>	Client should ensure to obtain a license from PESO, if the project exceeds the quantity of cylinders stored.

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Regulation	Enforcement Authority	Summary	Applicability	Required Action
The Central Motor Vehicles Rules 1989, and its amendments	Regional Traffic Office (RTO)	All vehicles in use shall obtain Pollution Control Check certificates and shall be driven by personnel with proper licenses.	Applicable as movement of construction vehicles and other vehicles for transportation of workers	Client to ensure compliance of the Section 39, Motor Vehicle Act, 1988 as amended in 2017 and Rule 47, Motor Vehicle Rule, 1989.
The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 and Kerala RFCLARR Rules 2015	Land Acquisition Officer and Resettlement and Rehabilitation Commissioner	An Act of Indian Parliament that regulates land acquisition and lays down the procedure and rules for granting compensation, rehabilitation and resettlement. The Act has provisions to provide fair compensation to those whose land is taken away, brings transparency to the process of acquisition of land to set up factories or buildings, infrastructural projects and assures rehabilitation of those affected.	Applicable Project's land acquisition is being carried out based on the requirements of this act.	Client should ensure that compensation and Resettlement and Rehabilitation benefits are provided as per this regulation to those who land is acquired for project.
Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996	Labour Commissioner	Regulates the employment and conditions of service of building and other construction workers and to provide for their safety, health and welfare measures and for other matters connected therewith or incidental thereto, like hours of work, weekly rest, wages, maintenance of records, canteen, latrine and urinal accommodation, health & safety at site, etc.	Applicable During construction & operation phase client will engage workers, directly or through contractors for project construction and operation works.	Client through its contractors ensure that workers' safety, health and welfare measures and for other matters connected like hours of work, weekly rest, wages, maintenance of records, canteen, latrine and urinal accommodation, health & safety at site, etc. should be provided as per norms of this regulation.
The Contract Labour (Regulations & Abolition) Act, 1970	Labour Commissioner	The Contract Labour (Regulations & Abolition) Act, 1970 requires every principal employer of an establishment to make an application to the registering officer in the prescribed manner for registering the establishment. The Act and its Rules apply to every establishment in which 20 or more workmen are employed on any day on the preceding 12 months as contract labour and to every contractor who employs or who employed on any day preceding 12 months, 20 or more workmen. It does not apply to establishments	Applicable During construction & operation phase client will engage workers, directly or through contractors for project construction and operation works.	Client should ensure that contractors have valid labour license. Client through its contractors should ensure that compensation to contract workers (own and vendors) should not be below daily wage rates as specified by Government of India, master roll should be maintained, employee ID card should be issued and safety, health and welfare measures of building and construction

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Regulation	Enforcement Authority	Summary	Applicability	Required Action
Workmen's Compensation Act, 1923 & Rules 1924	Labour Commissioner	Where the work performed is of intermittent or seasonal nature. An establishment wherein work is of intermittent nature will be covered by the Act and Rules if the work performed is more than 120 days in a year, and where work is of a seasonal nature if work is performed more than 60 days in a year.	The Act requires if personal injury is caused to a workman by accident arising out of and in the course of his employment, his employer should be liable to pay compensation in accordance with the provisions of this Act. The Act also gives a framework for calculating amount of compensation and wages.	Applicable During construction & operation phase client will engage workers, directly or through contractors for project construction and operation works.
Minimum Wages Act, 1948	Labour Commissioner	This Act provide for fixing minimum rates of wages in certain employments and requires the employer to provide to every worker engaged in a scheduled employment to be paid wages at a rate not less than the minimum rate of wages fixed by such notification for that class of employees in that employment without any deductions except as may be authorized within such time and subject to such conditions as may be prescribed.	This Act to regulate the employment of inter-state migrant workmen and to provide for their conditions of service and for matters connected therewith	Applicable During construction & operation phase client will engage workers, directly or through contractors for project construction and operation works.
Inter-State Migrant Workmen's (Regulation of Employment & Conditions of Service) Act, 1979	District Collector	It defines treasure specifically as "anything of any value hidden in the soil" and worth as little as 10 rupees (16 cents; 10 pence). The finder of such treasure, according to this law,	If migrant workers are engaged during construction as well as operation, maintenance work for project.	Applicable. If any treasure articles are found in project construction /
Indian Treasure Trove Act, 1878, modified up		Whenever any treasure exceeding in amount or value ten rupees is found, the finder shall,		

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Regulation	Enforcement Authority	Summary	Applicability	Required Action
to the 1st September 1949.		needs to inform the most senior local official of the "nature and amount or approximate value of such treasure and the place where it was found".	alignment area to be reported immediately.	as soon as practicable, give to the Collector notice in writing

The Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010 has been enacted to amend the Ancient Monuments and Archaeological Sites and Remains Act, 1958 and to make provision for validation of certain actions taken by the Central Government under the said Act. The act has come into force on January 23, 2010.	Not Applicable	As per The Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010 if the distance from Metro alignment is between 100m to 300m from the archaeological monuments prior approval is required for construction activities in regulated area of these monuments from Archaeological Survey of India.
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3.3 Clearances or Permissions required

The project has several components which would need certain permission or clearances from several authorities in environment sector. A brief summary has been prepared for necessary clearances or permission required/available for the project along with procedural guidelines and responsible authority is provided in Table 3-2

Table 3-2: Applicable Key Indian Legal Requirements – Environment, Health & Safety

S. No	Permits/Licenses/Certificate	Applicable Acts/Rules	Issuing Authority	Issued Date	Validity Date	Issued to	Remarks
1. Felling of Trees	<ul style="list-style-type: none"> The Kerala Preservation of Trees Act, 1986 The Kerala Restriction on Cutting and Destruction of Valuable Trees Rules, 1974 Kerala Forest Act, 1961 as amended 	<ul style="list-style-type: none"> Tree Officer, State Government Assistant Conservator of Forests, Kerala Forest Department District Tree Authority Forest Officer 	-	-	-	-	As informed by the Client, the project has obtained the required tree felling permission for the Petta to S.N. Junction section
2. CRZ clearance	<ul style="list-style-type: none"> Coastal Regulation Zone (CRZ) Notification, 2019 	<ul style="list-style-type: none"> Kerala Coastal Zone Management Authority (KCZMA) 	Not Obtained	Not Obtained	31/10/2022	KEC International Limited	As per the Coastal Zone Management Plan of Kerala Ernakulam District, it was observed the project would come under the preview of the Coastal Regulation Zone as per the Coastal Regulation Zone Notification, 2019.
3. Consent to Establish (CTE) and Consent to Operate (CTO) for Casting Yard at Eloor	<ul style="list-style-type: none"> Water (Prevention and Control of Pollution) Act, 1974; Air (Prevention and Control of Pollution) Act, 1981 & The Noise Pollution (Regulation and Control) Rules, 2000 and subsequent amendments. 	<ul style="list-style-type: none"> Kerala State Pollution Control Board (KSPCB) 	06/12/2019	31/10/2022	KEC International Limited	C TO was granted to KEC International Limited for its Casting Yard, Eloor, Ernakulam facility	
4. Consent to Establish and Consent to Operate for Muttom Depot	<ul style="list-style-type: none"> Water (Prevention and Control of Pollution) Act, 1974; Air (Prevention and Control of Pollution) Act, 1981 & The Noise Pollution (Regulation and Control) Rules, 2000 and subsequent amendments. 	<ul style="list-style-type: none"> Kerala State Pollution Control Board (KSPCB) 	Not Available	-	-	-	As per the KSPCB notification, "Railway Locomotive workshop" falls under Red category of non-industrial operation and hence would be required to obtain CTO from the KSPCB.
5. Authorization for Handling, Generation, Storage, Use & Transportation of Hazardous and Other Wastes	<ul style="list-style-type: none"> Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 (as amended) 	<ul style="list-style-type: none"> Kerala State Pollution Control Board (KSPCB) 	06/12/2019	31/10/2022	KEC International Limited	Hazardous Waste Authorization was available for Eloor Casting Yard. However, the same was not available for Muttom Depot.	

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S. No	Permits/Licenses/Certificates	Applicable Acts/Rules	Issuing Authority	Issued Date	Validity Date	Issued to	Remarks
6.	Hazardous and other Wastes	Bio-Medical Waste Management Rules, 2016	Kerala State Pollution Control Board (KSPCB)	-	-	-	Bio-Medical Waste Authorization for the Muttom Depot and Elloor Casting Yard was not available.
7.	Half yearly return (Form VII)	The Battery Management and Handling Rule, 2001	Kerala State Pollution Control Board (KSPCB)	-	-	-	10303 no. of batteries were reported to be used by KMRL (within trains and depots area). As per the responsibilities of bulk consumer, half yearly return - Form VII to be submitted to KSPCB was not available.
8.	Factory License for Casting Yard	• Factories Act, 1948 • The Building & Other Construction Workers Act 1996	Director Industrial Safety and Health (DISH)	-	-	-	As per the Factories Act, a Factory License is required as 'factory' means 'any premises having ten or more workers involved in a manufacturing process'. This will be applicable for the Casting Yard which is involved in manufacturing of precast Viaducts and has more than 10 workers. KEC / KMRL to look into this.
9.	No Objection Certificate (NOC) for groundwater extraction for construction and allied works	The Kerala Ground Water (Control and Regulation) Act, 2002	State Groundwater Authority Water Resources Department, Government of Kerala	NOC not available	-	-	As per the guidelines/criteria for groundwater abstraction in Kerala (with effect from 15.04.2018), NOC for withdrawal of groundwater for Infrastructure projects is required to be obtained. This will be applicable to all ground water wells, which are being used for the Project.
10.	Disposal of Construction and Demolition waste	Construction and Demolition Waste Management Rules, 2016	-	-	-	-	KMRL has an agreement with the MSTC Limited to dispose-off all categories of scrap material, machineries, miscellaneous articles, construction and demolition waste, etc. As informed by KMRL, the construction and demolition waste is used in road preparatory works, after processing, in nearby areas.
11.	Pollution Under Control (PUC) certificate for use of vehicles for all Construction vehicles	The Central Motor Vehicles Rule, 1989 Motor Vehicles Act with Rules, 1988 and amendments	Agency authorised by the State Government	Available	-	-	KMRL & KEC International Limited ensured that PUC License and Insurance of vehicles were available

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S. No	Permits/Licenses/Certificate	Applicable Acts/Rules	Issuing Authority	Issued Date	Validity Date	Issued to	Remarks
12. Proceedings to deal with chance finds	• Indian Treasure Trove Act, 1878, modified up to the 1st September 1949.	• District Collector	-	-	-	-	Whenever any treasure exceeding in amount or value ten rupees is found, the finder shall, as soon as practicable, give to the Collector notice in writing
13. License to store petroleum beyond Prescribed quantity.	• Petroleum Rules, 2002	• Chief Controller of Explosives/DC	Not applicable	-	-	-	During site visit, it was observed that the storage quantities of Class B petroleum product (diesel) were less than 2500 ltrs. In bulk and in individual receptacle it was less than 1000 ltrs. Approval from Chief Controller of Explosives should be obtained if the quantities exceed.
14. License to store Gas Cylinder	• The Gas Cylinder Rules, 2004	• Chief Controller of Explosives	Not applicable	-	-	-	During site visit, it was observed that compressed gas LPG cylinders used for cooking and compressed gas acetylene gas cylinder used for welding were less than 25 in numbers.
15. Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996	• Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996	• Labour Commissioner	26/11/2019	-	-	KEC-CCEC C JV	The license is granted for Construction of viaduct from Petta to S.N junction including 2 elevated stations with maximum of 300 employees.
16. Labour License	• Contract Labour (Regulation and Abolition) Act, 1970	• Office of Chief Labour Commissioner (Centre)	21/10/2020	24/10/2021	2021	KEC-CCEC C JV	The license has been renewed from 300 to 500 Labours.
17. Interstate Migrant certificate	• Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act 1979	• Licensing Officer, Chief Labour Commissioner Office, Ernakulam	20/12/2017	25/11/2020 (Expired)	2020	KEC-CCEC C JV	The license is granted for Construction of viaduct from Petta to S.N junction including 2 elevated stations with maximum of 150 employees.
18. Principal Employer certificate	• Contract Labour (Regulation and Abolition) Act, 1970	• Chief Labour Commissioner, Ernakulam	Information yet to be shared for review.	KMRL	Details of their registration were not available		
19. Registration under Kerala Private Security Agencies Rules, 2010	• Kerala Private Security Agencies Rules, 2010	• Joint Secretory and Controlling Authority			Two agencies currently providing security personnel for the project. Details of their registration were not available for review.		

3.4 Applicable International Standards and Guidelines

3.5 ADB Safeguard Policy Statement, 2009

In July 2009, ADB's Board of Directors approved the new Safeguard Policy Statement (SPS) governing the environmental and social safeguards of ADB's operations. The SPS builds upon ADB's previous safeguard policies on the Environment, Involuntary Resettlement, and Indigenous Peoples, and brings them into one consolidated policy framework with enhanced consistency and coherence, and more comprehensively addresses environmental and social impacts and risks. The SPS also provides a platform for participation by affected people and other stakeholders in the project design and implementation.

The SPS applies to all ADB-financed and/or ADB-administered projects and their components, regardless of the source of financing, including investment projects funded by a loan; and/or a grant; and/or other means, such as equity and/or guarantees. ADB works with borrowers and clients to put into practice the requirements of SPS.

The SPS supersedes ADB's Involuntary Resettlement Policy (1995), Policy on Indigenous Peoples (1998), and Environment Policy (2002). In accordance with the SPS, these previous policies apply to all projects and tranches of multi-tranche financing facility projects that were reviewed by ADB's management before 20 January 2010. The objectives of ADB's safeguards are to:

- Avoid adverse impacts of projects on the environment and affected people, where possible;
- Minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and
- Assist borrowers and clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

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

- Environmental safeguards;
- Involuntary Resettlement safeguards; and
- Indigenous Peoples safeguards.

To help borrowers and clients and their projects achieve the desired outcomes, ADB adopts a set of specific safeguard requirements that borrowers and clients are required to meet in addressing environmental and social impacts and risks. These safeguard requirements are as follows:

- Safeguard Requirements 1: Environment (Appendix 1 of SPS);
- Safeguard Requirements 2: Involuntary Resettlement (Appendix 2 of SPS);
- Safeguard Requirements 3: Indigenous Peoples (Appendix 3 of SPS); and
- Safeguard Requirements 4: Special Requirements for Different Finance Modalities (Appendix 4 of SPS).

In addition, ADB does not finance activities on the prohibited investment activities list (Appendix 5 of SPS). Furthermore, ADB does not finance projects that do not comply with its safeguard policy statement, nor does it finance projects that do not comply with the host country's social and environmental laws and regulations, including those laws implementing host country obligations under international law.

3.5.1 ADB Prohibited Investment Activities List

The following do not qualify for Asian Development Bank financing:

- Production or activities involving harmful or exploitative forms of forced labor, child labor;
- Production of or trade in any product or activity deemed illegal under host country laws or regulations or international conventions and agreements or subject to international phaseouts or bans, such as (a) pharmaceuticals, pesticides, and herbicides, (b) ozone-depleting substances,

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- (c) polychlorinated biphenyls and other hazardous chemicals, (d) wildlife or wildlife products regulated under the Convention on International Trade in Endangered Species of Wild Fauna and Flora, and (e) transboundary trade in waste or waste products;
- Production of or trade in weapons and munitions, including paramilitary materials;
 - Production of or trade in alcoholic beverages, excluding beer and wine;
 - Production of or trade in tobacco;
 - Gambling, casinos, and equivalent enterprises;
 - Production of or trade in radioactive materials, including nuclear reactors and components thereof;
 - Production of, trade in, or use of unbonded asbestos fibers;
 - Commercial logging operations or the purchase of logging equipment for use in primary tropical moist forests or old-growth forests; and
 - Marine and coastal fishing practices, such as large-scale pelagic drift net fishing and fine mesh net fishing, harmful to vulnerable and protected species in large numbers and damaging to marine biodiversity and habitats.

The present project is outside the purview of this prohibited list.

3.6 ADB POLICIES

3.6.1 Public Communications Policy (2011)

ADB's Public Communications Policy (2011) sets out disclosure requirements for various ADB activities, including safeguard requirement. Safeguard Requirements 2: Involuntary Resettlement (Appendix 2 of SPS); and Safeguard Requirements 3: Indigenous Peoples (Appendix 3 of SPS) sets out the need for meaningful consultation and information disclosure during project preparation and operation to the affected population and other key stakeholders. Key requirements include:

- Information Disclosure: The borrower/client will submit the following documents to ADB for disclosure on ADB's website as per the applicability with respect to the Project:
 - Draft EIA including draft EMP;
 - Final EIA/IEE;
 - Updated EIA/IEE and corrective active plan;
 - Environmental Monitoring Reports;
 - Resettlement Plan (RP); and
 - Indigenous Peoples Plan (IPP).
- Information disclosure to affected people or stakeholders: The borrower/client will provide relevant environmental information in a timely manner, in an accessible place and in a form and language(s) understandable to affected people and other stakeholders. For uneducated people, other suitable communication methods will be used.
- Consultation and Participation: The borrower/client will carry out meaningful consultation with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation.
- Timing and Frequency for consultation and participation: Meaningful consultation begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle,

3.6.2 Social Protection Strategy 2001

Social protection is a key step in ADB's battle to have Asia and the Pacific region "free of poverty." The Social Protection Strategy (SPS) spells out the scope of social protection and commitment of the ADB to develop priority interventions in five major elements including:

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- Labour market policies and programs designed to generate employment, improve working conditions and promote the efficient operations;
- Social insurance programs to cushion the risks associated with unemployment, ill health, disability, work-related injury and old age;
- Social assistance and welfare service programs for the vulnerable groups with inadequate means of support, including single mothers, the homeless, or physically or mentally challenged people;
- Micro and area-based schemes to address vulnerability at the community level, including micro-insurance, agricultural insurance, social funds and programs to manage natural disasters; and
- Child protection to ensure the healthy and productive development of children.

3.6.3 Operations Manual (OM) C3 Sector and Thematic Policies on Incorporation of Social Dimensions 2011

All ADB operations have social dimensions that need to be taken into account from the country strategy formulation, programming, and project processing phases onward. The key social dimensions, supported by specific ADB policies or strategies, include:

- Participation;
- Gender and development;
- Social safeguards; and
- Management of social risks, especially among vulnerable groups.

As per the policy, ADB operations incorporate social dimensions to ensure the following social development outcomes, especially for the poor, vulnerable, and excluded groups:

- Policies and institutions that recognize and promote greater inclusiveness and equity in access to services, resources, and opportunities;
- Greater empowerment to participate in social, economic, and political life; and
- Greater sense of security and ability to manage risks.

In pursuing these social development outcomes, ADB

- Encourages consultation with and participation by stakeholders (including the government, executing and implementing agencies, clients and/or beneficiaries, people affected by ADB-supported projects); provides them with opportunities to engage in key stages of the country strategy formulation, programming, and project cycles; and actively seeks, where appropriate, the cooperation of nongovernment organizations and other civil society groups in formulating, designing, implementing, monitoring, and evaluating projects;
- Addresses gender considerations in relevant aspects of ADB operations, including macroeconomic, sector strategy, country strategy formulation, and programming work, and in key stages of the project cycle; and proposes strategies to promote social inclusion and gender equality and to empower women;
- Integrates social analysis in preparing country partnership strategies and regional strategies and programs; identifies potential social issues during project preparation to ensure that the project design maximizes social benefits and avoids or minimizes social risks, particularly for vulnerable and marginalized groups; and
- Ensures that project design and implementation arrangements include actions to enhance benefits and to monitor and evaluate the distribution of the benefits of the project, with performance targets and indicators for monitoring and evaluating benefits included in the design and monitoring framework of the project performance management system.

3.6.4 Gender Mainstreaming Guidelines 2012

The projects of the Asian Development Bank (ADB) have four gender mainstreaming categories:

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- Category I: gender equity as a theme (GEN);
- Category II: effective gender mainstreaming (EGM);
- Category III: some gender elements (SGE); and
- Category IV: no gender elements (NGE).

The Gender Mainstreaming Guidelines 2012 provides a detailed overview on the definition, requirements and application of the above gender mainstreaming categories.

3.6.5 CORE ILO LABOUR STANDARDS

There are eight core International Labour Organization (ILO) conventions that align with, and further strengthen, the covenant requirements. They cover four 'Core Labour Standards':

- Conventions 29 and 105 ban forced labour and slavery
- Conventions 87 and 98 require countries to allow freedom of association and collective bargaining
- Conventions 100 and 111 ban workplace discrimination
- Conventions 138 and 182 set a minimum working age of 15 and ban the worst forms of child labour (e.g., bonded labour, hazardous labour, military conscription and sex trade)

3.6.6 ADB Safeguard Categories

3.6.6.1 Environment

Proposed projects are screened according to type, location, scale, and sensitivity and the magnitude of their potential environmental impacts, including direct, indirect, induced, and cumulative impacts. Projects are classified into the following four categories:

- **Category A.** A proposed project is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental and social impact assessment (ESIA), including an environmental management plan (EMP), is required.
- **Category B.** The proposed project's potential adverse environmental impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An initial environmental examination (IEE), including an EMP, is required.
- **Category C.** A proposed project is likely to have minimal or no adverse environmental impacts. An EIA or IEE is not required, although environmental implications need to be reviewed.
- **Category F1.** A proposed project involves the investment of ADB funds to or through a financial intermediary. The financial intermediary must apply and maintain an environmental and social management system, unless all of the financial intermediary's business activities have minimal or no environmental impacts or risks.

3.6.6.2 Involuntary Resettlement

The involuntary resettlement impacts of an ADB-supported project are considered significant if 200 or more persons will be physically displaced from home or lose 10% or more of their productive or income-generating assets. For those involving involuntary resettlement, a resettlement plan is prepared that is commensurate with the extent and degree of the impacts: the scope of physical and economic displacement and the vulnerability of the affected persons. Projects are classified into the following four categories:

- **Category A.** A proposed project is likely to have significant involuntary resettlement impacts. A resettlement plan, which includes assessment of social impacts, is required.
- **Category B.** A proposed project includes involuntary resettlement impacts that are not deemed significant. A resettlement plan, which includes assessment of social impacts, is required.
- **Category C.** A proposed project has no involuntary resettlement impacts. No further action is required.

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- **Category FI.** A proposed project involves the investment of ADB funds to or through a financial intermediary. The financial intermediary must apply and maintain an environmental and social management system, unless all of the financial intermediary's business activities are unlikely to generate involuntary impacts.

1.1.1.1 Indigenous Peoples

The impacts of an ADB-supported project on indigenous peoples is determined by assessing the magnitude of impact in terms of:

- customary rights of use and access to land and natural resources;
- socioeconomic status;
- cultural and communal integrity;
- health, education, livelihood, and social security status; and
- the recognition of indigenous knowledge; and
- the level of vulnerability of the affected Indigenous Peoples community. Projects are classified into the following four categories:
 - **Category A.** A proposed project is likely to have significant impacts on indigenous peoples. An Indigenous Peoples Plan (IPP), including assessment of social impacts, is required.
 - **Category B.** A proposed project is likely to have limited impacts on indigenous peoples. An IPP, including assessment of social impacts, is required.
 - **Category C.** A proposed project is not expected to have impacts on indigenous peoples. No further action is required.
 - **Category FI.** A proposed project involves the investment of ADB funds to or through a financial intermediary. The financial intermediary must apply and maintain an environmental and social management system, unless all of the financial intermediary's business activities are unlikely to have impacts on indigenous peoples.

The categorisation for the present project has been carried out in Section 5.8

3.7 IFC Performance Standards Framework

In addition to the ADB's SPS 2009 framework, the IFC Performance Standards (2012) framework has also been taken into consideration while assessing this project. The IFC Performance Standards Framework accounts for the following eight (8) performance standards:

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

3.8 WB/IFC EHS Guidelines

The EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP), as defined in IFC's Performance Standard 2: Labour & working Conditions (Occupational Health and Safety), Performance Standard 3: Resource Efficiency and Pollution Prevention.

Following EHS Guidelines were referred for this E&S compliance audit.

- General EHS Guidelines, 2007; and
- EHS Guidelines for Toll Roads, 2007.

3.9 Integrated Applicability Matrix of the Project to respective ADB Safeguards and IFC PS Requirements

The various EHS and Social aspects that have been considered while assessing the project, the governing ADB safeguards and IFC Performance Standards and their respective applicability to the project is indicated in the below mentioned table. An integrated approach has been adopted for the assessment taking into consideration both these development sector frameworks on EHS and Social risk management for projects. A more detailed and comprehensive gap assessment vis-à-vis each of the aspects highlighted has been covered in Section 5 of this report.

Table 3-3: EHS and Social aspects considered for the assignment, the relevant ADB and IFC safeguards and the applicability of the same to the Project

Sr. No	EHS and Social Aspect Under Consideration	ADB Safeguard Requirements	IFC PS Requirements	Requirements of the Safeguard/PS	Applicability to the project
1.	Assessment and Management of Environmental and Social Risks and Impacts	Safeguard Requirements 1: Environment	PS 1: Assessment and Management of Environmental and Social Risks and Impacts	Aims to assesses the existing social and environmental management systems of a company/project and to identify the gaps with respect to their functioning, existence and implementation of any Environmental and Social Management Plan (ESMP) and procedures, a defined EHS Policy, organization chart with defined roles and responsibilities, risk identification and management procedures as well as processes like stakeholder engagement and grievance management.	Applicable
2.	Labour and Working Conditions	ADB Core Labour Standards	PS 2: Labour and Working Conditions	Covers following themes: human resource policy and management, workers' organization, non-discrimination and equal opportunity, retrenchment, protecting the workforce and occupational health and safety. It applies to workers directly engaged by the client (direct workers), workers engaged through third parties to perform work related to core business processes of the project for a substantial duration (contracted workers), as well as workers engaged by the client's primary suppliers (supply chain workers).	Applicable.
3.	Environmental Pollution Risks and Controls	Safeguard Requirements 1: Environment	PS 3: Resource Efficiency and	Key themes covered under are: pollution prevention, resource conservation and energy efficiency, wastes, hazardous materials,	Applicable

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Sr. No	EHS and Social Aspect Under Consideration	ADB Safeguard Requirements	IFC PS Requirements	Requirements of the Safeguard/PS	Applicability to the project
4.	Community Safety Security and Health	Safeguard Requirements 1: Environment Operations Manual (OM) C3 Sector and Thematic Policies on Incorporation of Social Dimensions 2011	Pollution Prevention	emergency preparedness and response, greenhouse emissions, pesticide use and management.	Assessment is required to ascertain how KMRL intends to minimize water pollution (from wastewater generated during construction/operation phase, leakage of fuel/lubricants from storage areas, maintenance, etc.), noise emission (from maintenance procedures); municipal solid waste from labor camps and guest houses and other areas; hazardous wastes generated from casting yard, storage area and other location. What management plans and systems are in place, and what measures it plans to take to conserve and use resources more efficiently.
5.	Land Acquisition and associated impacts	Safeguard Requirements 2: Involuntary Resettlement	PS 4: Community Health, Safety and Security	Key areas of compliance screened includes material safety, natural resource issues, exposure to disease, emergency preparedness and response, and security personnel.	Applicable Coverage of safety of the road users, the local community along the ROW and emergency response system planned to be followed by KMRL for road diversion and other accident events. A site barricading plan drawing, and traffic diversion plan have been prepared to safeguard the community from construction work. An Emergency preparedness plan has been developed by KEC-CCECC for construction phase to capture the relevant elements and the assessment of the adequacy of the same has been carried out.
		Operations Manual (OM) C3 Sector and Thematic Policies on Incorporation of Social Dimensions 2011	PS 5: Land Acquisition and Involuntary Resettlement	The key themes covered under this are: compensation and benefits for displaced persons, consultation and grievance mechanism, resettlement planning and implementation, physical displacement, economic displacement.	Applicable The entire land for the project has been acquired through a government acquisition process which is involuntary in nature and has associated social and The ADB/PS safeguards private sector

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Sr. No	EHS and Social Aspect Under Consideration	ADB Safeguard Requirements	IFC PS Requirements	Requirements of the Safeguard/PS	Applicability to the project
	Policies on Incorporation of Social Dimensions 2011	responsibility to supplement government actions and bridge the gap between governments assigned entitlements and procedures and the requirements these financial institutions.		economic implications for the Project Affected Families and persons. Both compensation and Resettlement or Rehabilitation provisions were made through monetary payments, not involving any land-for-land or civic amenity provisions. The land acquisition for RoW widening for IA and IB is completed, it is partially completed for IA, and it is yet to begin for IB stretch.	
6.	Ecology and Biodiversity	Safeguard Requirements 1: IFC PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	PS 6: Indigenous Peoples Operations Manual (OM) C3 Sector and Thematic Policies on Incorporation of Social Dimensions 2011	The key themes covered are natural habitat, critical habitat, legally protected areas, international introduction of alien species, and living natural resources (natural and plantation forest, aquatic resources etc.) are sustainably managed.	Applicable The key themes covered are: avoidance of adverse impacts, consultation and informed participation, impacts on traditional or customary lands under use, relocation of IPs from traditional or customary lands, and cultural resources.
7.	Impact on Ethnic and Indigenous Community	Safeguard Requirements 3: PS 7: Indigenous Peoples Operations Manual (OM) C3 Sector and Thematic Policies on Incorporation of Social Dimensions 2011	PS 7: Indigenous Peoples Operations Manual (OM) C3 Sector and Thematic Policies on Incorporation of Social Dimensions 2011	The key themes covered are: avoidance of adverse impacts, consultation and informed participation, impacts on traditional or customary lands under use, relocation of IPs from traditional or customary lands, and cultural resources.	Not applicable It was reported by KMRL project representatives and land acquisition government authorities of Ernakulam that no person belong to Scheduled Tribe community has been impacted due to the project activities.
8.	Local Cultural Heritage and Traditions	Safeguard Requirements 3: PS 8: Cultural Heritage Indigenous Peoples Operations Manual (OM) C3 Sector and Thematic Policies on Incorporation of Social Dimensions 2011	PS 8: Cultural Heritage	Cultural heritage refers to (i) tangible forms of cultural heritage; (ii) unique natural features or tangible objects that embody cultural values; and (iii) certain instances of intangible forms of culture that are proposed to be used for commercial purposes.	Applicable The project has affected multiple religious structures falling within the alignment and ROW which has resulted in partial demolition of the boundary walls, parking spaces and other facilities associated with the religious structures.

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3.8.1 Applicable International Conventions

Environmental problems which migrate beyond the jurisdiction (Trans-boundary) require power to control such issues through international co-operation by either becoming a Contracting Party (CP) i.e. ratifying treaties or as a Signatory by officially signing the treaties and agreeing to carry out provisions of various treaties on environment and social safeguards. The relevant international conventions are as provided in Table 3-4.

Table 3-4: Relevant International Conventions

S. International N. Conventions	Salient Features	Applicability & Guidelines
1. Montreal Protocol on Substances That Deplete the Ozone Layer (and subsequent Amendments)	India signed the Montreal Protocol along with its London Amendment on 17-9-1992 and also ratified the Copenhagen, Montreal and Beijing Amendments on 3rd March 2003.	Usage of ozone depleting substances Client and contractor should ensure that ozone depleting substances are not used for project related activities.
2. Kyoto Protocol	The Kyoto protocol was signed by India in August 2002 and ratified in February 2005. The convention pertains to the United Nations framework on Climate Change. The 3rd Conference of the Parties to the Framework Convention on Climate Change (FCCC) in Kyoto in December 1997 introduced the Clean Development Mechanism (CDM) as a new concept for voluntary greenhouse-gas emission reduction agreements between industrialized and developing countries on the project level.	Greenhouse-gas emission Client and contractor should make efforts to reduce all emissions from project related activities. All property development work including planning, designing & construction of all structures is planned as per Indian Green Building Council (IGBC) norms. IGBC Green New Buildings rating system encourages use of water in a self-sustainable manner through reduce, recycle and reuse strategies.
3. International Labour Organization conventions	India has also ratified many of the International Labour Organization conventions that are relevant to the Project including: C1 Hours of Work (Industry) Convention, 1919 (14:07:1921, ratified); C5 Minimum Age (Industry) Convention, 1919 (09:09:1955, ratified); C11 Right of Association (Agriculture) Convention, 1921 (11:05:1923, ratified); C14 Weekly Rest (Industry) Convention, 1921 (11:05:1923, ratified); C29 Forced Labour Convention, 1930 (30:11:1954, ratified) & C105 Abolition of Forced Labour Convention, 1957 (18:05:2000, ratified); C100 Equal Remuneration Convention, 1951 (25:09:1958, ratified); C107 Indigenous and Tribal Populations Convention, 1957 C111 discrimination (Employment and Occupation) Convention, 1958 (03:06:1960, ratified)	Labour working conditions, accommodation and wages Client and contractor should follow all applicable national and state regulations related to labour working conditions, accommodation, wages and benefits.
4. UN Guiding principles on Business and Human Right	The United Nations (UN) Guiding Principles on Business and Human Rights (GPs), which were endorsed by the Human Rights Council (HRC) in June 2011, are built on three pillars: states' duty to protect human rights, corporate responsibility to respect human rights, and access to effective remedies. All three pillars of the GPs – especially Pillar 1 and Pillar 3 –	

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S. International N. Conventions	Salient Features	Applicability & Guidelines
	<p>require states to take a number of measures to ensure that business enterprises do not violate human rights and that effective remedies are available in cases of violation.</p> <p>The UN Working Group on the issue of human rights and transnational corporations and other business enterprises (UNWG) 'strongly encourages all states to develop, enact and update' a national action plan (NAP) on business and human rights (BHR) as part of states' responsibility to disseminate and implement the GPs. In June 2014, the HRC passed a resolution calling upon states to develop NAPs. As of 29 February 2016, ten states have drawn up NAPs of which India was a party wherein it reaffirms India's commitments towards realization of human rights and promotion of socially responsible businesses in the country.</p>	
5. Convention on Biological Diversity, 1992 (CBD or Rio Convention)	<p>India is a party to CBD since 1994. The objectives of the CBD are the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising from commercial and other utilization of genetic resources. The agreement covers all ecosystems, species, and genetic resources.</p>	<p>Disturbance to biological diversity, migratory species, wetlands endangered species</p> <p>Client and contractor should ensure that there is minimal / no disturbance to biological diversity, migratory species, wetlands and endangered species due to project activity / workers.</p>
6. Convention on the Conservation of Migratory Species of Wild Animals, 1983 (CMS or "Bonn Convention")	<p>India is a Party to CMS since 1983. CMS is an intergovernmental treaty aimed at conservation and sustainable use of migratory animals and their habitats. It brings together Range States through which migratory animals pass and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range. Parties strive towards protecting migratory species, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them.</p>	
7. Convention on Wetlands of International Importance especially as Waterfowl Habitat, 1971 (Ramsar Convention)	<p>India is a Contracting Party to the Ramsar Convention since 1982. It is an intergovernmental treaty that provides a framework for the conservation and wise use of wetlands and their resources. It includes all lakes and rivers, underground aquifers, swamps and marshes, wet grasslands, peatlands, oases, estuaries, deltas and tidal flats, mangroves and other coastal areas, coral reefs, and also human-made sites, such as fishponds, rice paddies, reservoirs and salt pans. Contracting Parties commit to work towards the wise use of all their wetlands, designate suitable wetlands for the list of Wetlands of International Importance (the "Ramsar List") and ensure their effective management, as well as, cooperate internationally on transboundary wetlands, shared wetland systems and shared species</p>	

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S. International N. Conventions	Salient Features	Applicability & Guidelines
8. Convention on International Trade in Endangered Species of Wild Flora and Fauna, 1975 (CITES)	India is a Party to CITES since 1976. It is an international agreement between governments aimed at ensuring that international trade in specimens of wild animals and plants does not threaten the survival of such species. Each CITES Party is expected to adapt its domestic legislation to ensure that the CITES framework is implemented at the national level.	
9. Convention Concerning the Protection of World Cultural and Natural Heritage, 1972 (UNESCO World Heritage Convention) (WHC).	India has been a State Party to the WHC since 1977. The WHC aims to identify and protect the world's natural and cultural heritage considered to be of outstanding universal value. State Parties to the WHC are expected to identify and nominate properties on their national territory to be considered for inscription on the World Heritage List, giving details of how a property is protected and providing a management plan for its upkeep. States Parties are also expected to protect the World Heritage values of the properties inscribed.	Disturbance to Cultural and Natural Heritage The project alignment is not located between 100 to 300 m from any ancient monuments and archaeological sites and remains declared as per Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010. In case of discovery of any ancient monuments and archaeological sites and remains or in case of any land acquisition impacting any religious structures, all required precautions should be taken by client and contractor so that impacts are minimized / removed.

3.10 Applicable Environmental Standards

3.10.1 Ambient Air Quality

As per the IFC EHS guidelines (April 2007), "the ambient air quality standards are ambient air quality levels established and published through national legislative and regulatory processes and ambient quality guidelines refer to ambient quality levels primarily developed through clinical, toxicological, and epidemiological evidence (such as those published by the World Health Organization)". National Ambient Air Quality Standards (NAAQS), as notified under Environment (Protection) Rules 1986 and revised through Environment (Protection) Seventh Amendment Rules, 2009 are given Table 3-5:

Table 3-5: National Ambient Air Quality Standards

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (notified by Central Government)
Sulphur Dioxide (SO ₂), µg/m ³	Annual*	50	20
	24 Hours**	80	80
Nitrogen Dioxide (NO ₂), µg/m ³	Annual*	40	30
	24 Hours**	80	80
Particulate Matter (size less than 10 µm) or PM ₁₀ , µg/m ³	Annual*	60	60
	24 Hours**	100	100
Particulate Matter (size less than 2.5 µm) or PM _{2.5} , µg/m ³	Annual*	40	40
	24 Hours**	60	60
Ozone (O ₃), µg/m ³	8 Hours**	100	100

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Pollutant	Time Weighted Average	Concentration in Ambient Air	
		<i>Industrial, Residential, Rural and other Areas</i>	<i>Ecologically Sensitive Area (notified by Central Government)</i>
	1 Hour**	180	180
Lead (Pb), $\mu\text{g}/\text{m}^3$	Annual*	0.5	0.5
	24 Hours**	1	1
Carbon Monoxide (CO), mg/m^3	8 Hours**	2	2
	1 Hour**	4	4
Ammonia (NH_3), $\mu\text{g}/\text{m}^3$	Annual*	100	100
	24 Hours**	400	400
Benzene (C_6H_6), $\mu\text{g}/\text{m}^3$	Annual*	5	5
Benzo (O) Pyrene (BaP), particulate phase only, ng/m^3	Annual*	1	1
Arsenic (As), ng/m^3	Annual*	6	6
Nickel (Ni), ng/m^3	Annual*	20	20

*Annual arithmetic mean of minimum 104 measurements in a year taken twice a week, 24 hourly at uniform interval

**24 hourly or 8 hourly or 1 hourly value as applicable shall be complied with 98% of the time in a year. 2% of the time they may exceed, but not on 2 consecutive days. Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

3.10.2 Ambient Noise Standards

As per the EHS guidelines of IFC, for residential, institutional and educational area, the one hourly equivalent noise level (Leq hourly) for day time (6.00 a.m. to 10.00 p.m.) is **55 dB (A)** while the Leq hourly for night time (10.00 p.m. to 6.00 a.m.) is prescribed as **45 dB (A)**. Noise standards notified by the MoEF&CC vide gazette notification dated 14th February 2000 based on the A-weighted equivalent noise level (Leq) are as presented in Table 3-6.

Table 3-6: Ambient Noise Standards

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

*Silence zone is defined as area up to 100 m around premises of hospitals, educational institutions and courts. Use of vehicle horns, loudspeakers and bursting of crackers are banned in these zones.

3.10.3 Noise Standards for Occupational Exposure

Noise standards in the work environment are specified by Occupational Safety and Health Administration (OSHA-USA) which in turn are being enforced by Government of India through model rules framed under the Factories Act.

Table 3-7: Standards for Occupational Noise Exposure

<i>Total Time of Exposure per Day in Hours (Continuous or Short-term Exposure)</i>	<i>Sound Pressure Level in dB(A)</i>
8	90
6	92
4	95

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3	97
2	100
3/2	102
1	105
3/4	107
1/2	110
1/4	115
Never	>115

No exposure in excess of 115 dB (A) is to be permitted.

For any period of exposure falling in between any figure and the next higher or lower figure as indicated in column (1), the permissible level is to be determined by extrapolation on a proportionate scale.

3.10.4 Water Quality Standards

The designated best use classification as prescribed by CPCB for surface water is as given in Table 3-8.

Table 3-8: Primary Water Quality Criteria for Designated Best Use Classes

Designated-Best-Use	Class	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	<ul style="list-style-type: none"> Total Coliforms Organism MPN/100ml shall be 50 or less pH between 6.5 and 8.5 Dissolved Oxygen 6mg/l or more Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organised)	B	<ul style="list-style-type: none"> Total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	<ul style="list-style-type: none"> Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wildlife and Fisheries	D	<ul style="list-style-type: none"> pH between 6.5 to 8.5 Dissolved Oxygen 4mg/l or more Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	<ul style="list-style-type: none"> pH between 6.0 to 8.5 Electrical Conductivity at 25°C micro mhos/cm Max.2250 Sodium absorption Ratio Max. 26 Boron Max. 2mg/l
Below-E		<ul style="list-style-type: none"> Not Meeting A, B, C, D & E Criteria

Source: Central Pollution Control Board

As per the IFC EHS guidelines, the treated sewage discharge is required to meet the following guidelines.

Table 3-9: Treated sewage discharge guidelines as per IFC

S. No.	Parameter	Guideline Value
1.	pH	6-9
2.	BOD	30mg/l
3.	COD	125 mg/l
4.	Total Nitrogen	125 mg/l
5.	Oil and Grease	10 mg/l
6.	Total Suspended Solids	50 mg/l
7.	Total coliform bacteria	400 MPN/100 ml

4. Environmental and Socio-Economic Baseline

This section of the report presents information on the baseline condition of the physical, chemical, biological and social environments within the project area.

The core area for ESIA study has been considered as 500 m on either side from centre of proposed alignment. The buffer area has been considered as 10 km radius area from centre of alignment area. Site reconnaissance survey and baseline monitoring was carried out in core area. Figure 4-1 presents the Area of Influence for the project depicting the buffer and core zone.

Primary baseline information was collected on site from project area and area of influence (upto 5 km radius along the alignment). Existing information sourced from scientific literature], engineering studies, technical reports and community socio-economic studies were used wherever available. Activities that facilitated establishment of the baseline data in the report include site survey, ecological survey, social consultations and interviews, environmental monitoring, processing of satellite imagery and secondary data review from established sources such as Indian Meteorological Department (IMD) and Census of India amongst others.

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Asian Development Bank

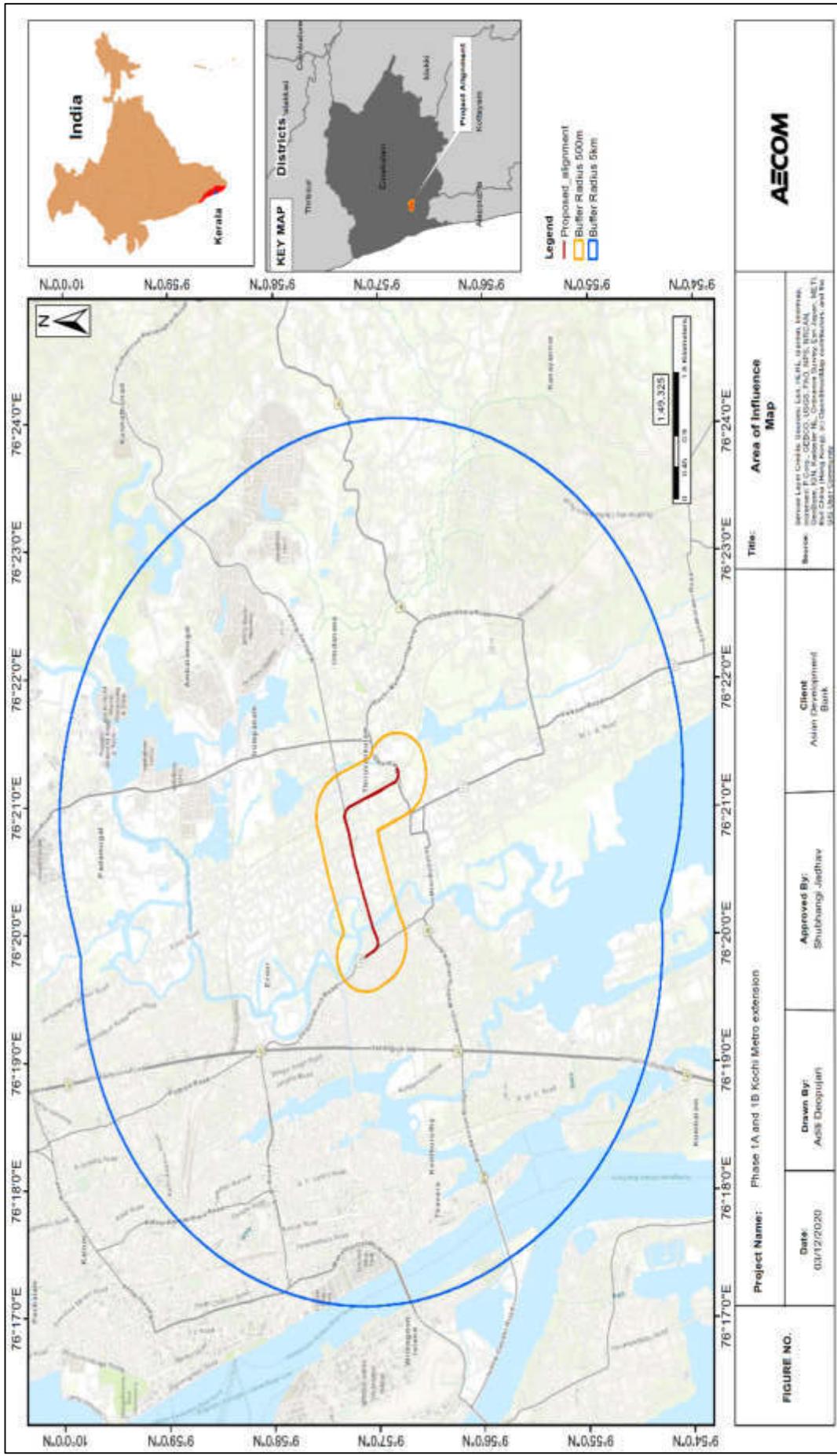


Figure 4-1: Area of Influence

4.1 Environmental Baseline

Primary data was collected from the 6th to the 11th of November 2020. Secondary data for the monitoring carried out by KEC-CCECC as instructed in the contractor agreement by KMRL, has also been presented. Environmental monitoring was undertaken for ambient air quality, surface water and drinking water quality, ambient noise levels and vibration. Parameters monitored under environmental aspects are given in Table 4-1.

Table 4-1: Environmental Parameters Monitored for Primary Baseline Data Collection

Aspect	Details
Ambient Air Quality	Information on ambient air quality was collected through monitoring of ambient air quality for 24 hours for parameters such as PM _{2.5} , PM ₁₀ , Nitrogen Dioxide (NO _x), Sulphur Dioxide (SO ₂), Ozone, Lead, Carbon monoxide, Benzene (C ₆ H ₆), Benzo(a)Pyrene (BaP), Arsenic (As), Nickel (Ni) at the following locations: <ul style="list-style-type: none"> • Casting yard and labour colony at Kalamassery • Material storage yard and labour colony at Irumpanam
Surface Water Quality	Two surface water grab samples were collected for analyses of the following parameters: <u>Organoleptic and Physical Parameters:</u> Colour, Odour, pH, Taste, Turbidity, Total Dissolved Solids <u>General Parameters:</u> Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Aluminium (as Al), Ammonia (as total ammonia-N), Anionic detergents (as MBAS), Barium (as Ba), Boron (as B), Calcium (as Ca), Chloramines (as Cl ₂), Chloride (as Cl), Copper (as Cu), Fluoride (as F), Free residual chlorine, Iron (as Fe), Magnesium (as Mg), Manganese (as Mn), Nitrate (as NO ₃), Phosphorus (as P), Selenium (as Se), Silver (as Ag), Sulphate (as SO ₄), Sulphide (as H ₂ S), Total alkalinity as calcium carbonate, Total hardness (as CaCO ₃), Zinc (as Zn), Cadmium (as Cd), Cyanide (as CN), Lead (as Pb), Mercury (as Hg), Molybdenum (as Mo), Nickel (as Ni), Pesticides, Polychlorinated biphenyls, Total arsenic (as As), Total chromium (as Cr). <u>Bacteriological Parameters:</u> E. coli bacteria, Total coliform bacteria, Phytoplankton & zooplankton profile
Drinking Water Quality	Two grab samples were collected from Casting yard and labour colony at Kalamassery and Material storage yard and labour colony at Irumpanam for pH, Electrical Conductivity, Temperature, Colour, Odour, Taste, Turbidity, Salinity, Total Dissolved Solid (TDS), Total Hardness (CaCO ₃), Alkalinity (CaCO ₃), Chloride (Cl), Calcium (Ca), Magnesium (Mg), Fluoride (F), Nitrate (NO ₃), Sulphate (SO ₄), Residual Chlorine, Chloramine (Cl ₂), Cyanide (CN), Hexavalent Chromium (Cr+6), Phenol (C ₆ H ₅ OH), Total Phosphorus (P), Free Ammonia (NH ₃), Total Nitrogen, Dissolved Oxygen (DO), Biochemical Oxygen demand (BOD), Chemical Oxygen demand (COD), SAR, Sodium, Potassium, Aluminium (Al), Manganese(Mn), Iron (Fe), Nickel (Ni), Copper (Cu), Boron, Zinc (Zn), Arsenic (As), Selenium(Se), Molybdenum (Mo), Cadmium (Cd), Barium(Ba), Mercury(Hg), Lead(Pb), Total Coliform, Faecal Coliform
Ambient Noise Quality	Ambient noise quality was monitored to determine hourly equivalent noise levels for 24 hours. The noise sampling was done for 24 hrs., once on a weekday and once on a weekend at the following eight (8) locations: <ul style="list-style-type: none"> • Near religious structure at metro turning towards Petta station • Near Chembakkara Canal • Vadakkekotta station • S.N. Junction • Near Kerala Cooperative Milk Marketing Federation unit and metro turning towards Tripunithura station • Tripunithura station • Casting yard and labour colony at Kalamassery • Material storage yard and labour colony at Irumpanam
Vibration	One-time baseline vibration levels were monitored for 24 hr at the following 6 locations: <ul style="list-style-type: none"> • Near religious structure at metro turning towards Petta station • Near Chembakkara Canal • Vadakkekotta station • S.N. Junction • Near Kerala Cooperative Milk Marketing Federation unit and metro turning towards Tripunithura station • Tripunithura station

Environmental monitoring locations have been illustrated in Figure 4-2, and Figure 4-3.

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Figure 4-2: Map showing Environment Monitoring location at the Alignment and Associated facilities

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Figure 4-3: Monitoring locations at Eloor Casting Yard

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Table 4-2: Environmental Monitoring Locations

S. No.	Aspect	Monitoring Location/Code	Latitude/Longitude	Monitoring Location	Direction from the project site	Rationale
1. Ambient Air	AAQ 1	1112902.76 m N 644263.47 m E	Eloor Casting Yard	Northwest of project site	Assess impact due to batching plant, DG Set and labour camp	
		1102566.12 m N 648495.05 m E	Stock Yard - Irumpanam	Northeast of project site	Assess impact due to labour camp and DG Set	
2. Surface Water	SQ 1	1100324.89 m N 646232.07 m E	North of Chembakkara	North of project site	Upstream and Downstream of the Project Site	
	SQ 2	1100255.46 m N 646260.92 m E	South of Chembakkara	South of project site		
3. Ambient Noise	NQ 1	1100219.68 m N 646117.73 m E	Near Petta Mosque	Along Alignment – Eastern end	Assess impacts at sensitive receptor	
	NQ 2	1100343.12 m N 646391.51 m E	Golden Fork	Along Alignment – Eastern end	Heavy commercial and residential area.	
	NQ 3	1100488.39 m N 646808.48 m E	Proposed Vadakkekotta Station	Along Alignment – Eastern end	Assess impacts near church and proposed Vadakkekotta Station	
	NQ 4	1100716.27 m N 647614.08 m E	SN Junction	Along Alignment – Central Portion	Assess impacts near residential area	
	NQ 5	1100784.80 m N 647877.38 m E	Under FOB Near Milma Dairy	Along Alignment – Central Portion, near curve	Assess impacts near mixed use area (diary and residential)	
	NQ 6	1100191.65 m N 648249.29 m E	Tripunithura Station	Along Alignment – Western Portion	Cumulative impacts from Tripunithura Station	
	NQ 7	1112914.21 m N 644266.13 m E	Eloor Casting Yard	North of Alignment	Assess impact on labour camp	
	NQ 8	1102583.40 m N 648490.35 m E	Irumpanam Stock Yard	Northeast of the Alignment	Assess impact on labour camp	
4. Vibration	VB 1	9°57'03.0"N 76°20'02.1"E	Near Petta Mosque	Along Alignment – Eastern end	Assess impacts at sensitive receptor	
	VB 2	9°57'05.8"N 76°20'09.1"E	Near Golden Fork Hotel	Along Alignment – Eastern end	Assess impacts near heavy commercial and residential area	
	VB 3	9°57'09.7"N 76°20'21.8"E	Opposite to HP Petrol Pump	Along Alignment – Eastern end	To ascertain impacts before Proposed Vadakkekotta Station	
	VB 4	9°57'17.3"N 76°20'46.9"E	Central Bank of India	Along Alignment – Central Portion	Assess impacts near commercial area	
	VB 5	9°57'19.2"N 76°20'57.4"E	Under ROB Near Milma Dairy	Along Alignment – Central Portion, near curve	Assess impacts near mixed use area (diary and residential)	
5. Drinking Water Quality	VB 6	9°57'00.1"N 76°21'08.2"E	Tripunithura Railway Station	Along Alignment – Western Portion	Cumulative impacts from Tripunithura Station	
	DW 1	1112914.21 m N 644266.13 m E	Eloor Casting Yard	North of Alignment	Access drinking water quality at the labour camp	
	DW 2	1102583.40 m N 648490.35 m E	Irumpanam Stock Yard	Northeast of the Alignment	Access drinking water quality at the labour camp	

DRAFT**4.1.1 Climate and Meteorology¹³**

Kochi shows tropical monsoon climate. The maximum daily temperature is noted as 33°C with minimum daily temperature as 23°C. Heavy rains accompanied by thunder are common from June to September due to the South-West monsoon. Light showers are experienced from October to December due to the North-West monsoon. The average annual rainfall is about 3014.8 mm with an average 124 rainy days annually with majority of the rainfall received from the South-West monsoon. The average wind speed is 2.8 kilometer per hour.

4.1.1.1 Rainfall

Based on review of CGWB's 2013 GW brochure for Ernakulam district, the district experiences heavy rainfall during southwest monsoon season followed by northeast monsoon. During the other months the rainfall is considerably less. March, April and May are the hottest months. December to February are the coldest months

The district receives on an average 3359.2 mm (based on 1901-99 data) of rainfall annually. The annual rainfall ranges from 3233 to 3456 mm at different places of the district. The rainfall is less in the western part of the district and gradually increase towards the east. Maximum rainfall is received around Neriamangalam area in the eastern part where the normal annual rainfall is found to be 5883 mm. While Kochi, which is in the western part receives around 3233 mm rainfall annually.

The annual average rainfall of Ernakulam district from 2007 to 2011 is given in Table 4. South-west monsoon season contributes nearly 67.4% of total rainfall of the year, followed by the north-east monsoon which contributes nearly 16.6% and the balance of 16% is received during the month of January to May as summer showers. The average monthly rainfall distribution for Ernakulam district (2007 to 2011) is given in Table 4-3 and that for Kochi is listed in Table 4-4.

Table 4-3: Average Annual Rainfall (in mm) for Ernakulam District

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
2014	0	11.1	22.4	90.7	287.9	550.1	650.2	877	298.8	434.8	118.5	94
2015	2.4	0.5	37.2	229.3	176.2	573.9	367.2	241.2	393.8	355	332.5	182.3
2016	0.4	91.4	3.4	43.8	322.8	624.6	620.4	238.7	85.7	160.5	115.1	19.5
2017	16.8	0	97.9	31.4	306	706.3	435.4	415.8	445.3	293	217.8	28.1
2018	1.4	7.1	52.5	193.2	324.9	833.5	1044.2	648.4	63.1	402.7	246.9	56.6

Source: IMD ([http://hydro.imd.gov.in/hydrometweb/\(S\(pqmrzsap2tsilw55cnn32c55\)\)/DistrictRaifall.aspx](http://hydro.imd.gov.in/hydrometweb/(S(pqmrzsap2tsilw55cnn32c55))/DistrictRaifall.aspx))

Table 4-4: Monthly total rainfall (in mm) and no. of rainy days for Kochi

Month	Monthly Total (mm)	Number of Rainy days
January	24.3	1.1
February	27.1	1.2
March	45	2.6
April	113.1	6.9
May	284.5	11
June	700.3	23
July	575.5	22.8
August	378.8	19
September	310.3	13.4
October	366.6	14.2
November	150.4	7.2

¹³ Climatological Normals 1981-2010, Indian Meteorological Department

4.1.1.2 Wind Speed

Based on review of Atlas of wind rose of 1971-2000 (India Meteorological Department), the annual variations in average wind speed recorded at 0300 UTC at Kochi (Cochin) during the period 1971-2000 range between 1.1 to 1.5 mps. The highest monthly mean wind speed obtained is 1.6 mps in June followed by 1.5 mps in January and July. The lowest monthly mean wind speed is 1.1 mps in March, April, October and November. Annual wind speed distribution irrespective of wind direction at 0300 UTC at Kochi (Cochin) suggests 1.5 mps to 4.5 mps as the most common wind speed which occurred on 34.4% of the time during the period 1971-2000. While the number of occasions with wind speed in the range 4.5 mps to 7.0 mps are 1.1%, wind speed more than 7.0 mps are rare.

Annual wind rose prepared from daily surface wind data recorded at 0300 UTC for 1971 to 2000 for Cochin (Kochi) (NAS) indicates that 23% of the years the winds blow from the northeast (NE) to east (E). Average wind speed of 4.5 mps to 7mps can be seen from many directions in the wind rose. The wind is seldom from south southeast (SSE) to the west southwest (WSW). Windrose is depicted in Table 4-4.

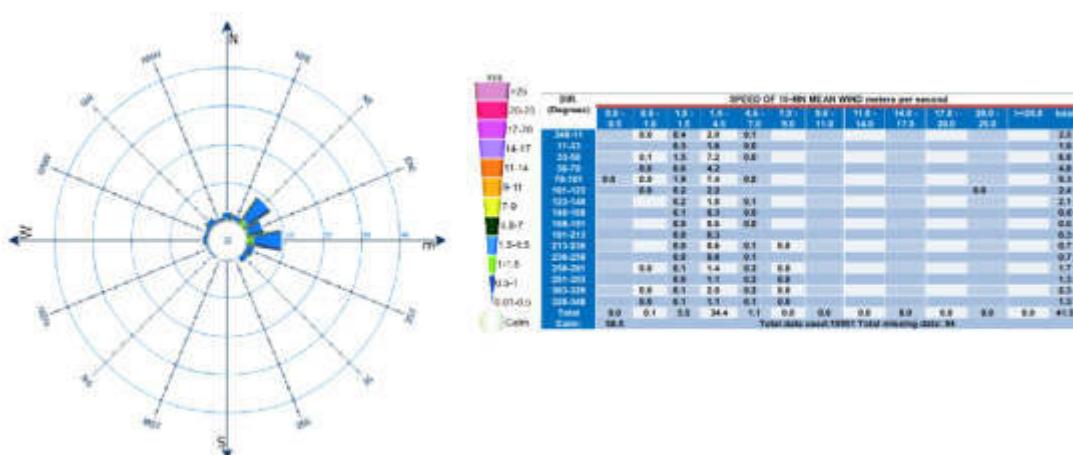


Figure 4-4: Windrose

Source: Windrose of 1971-2000 (India Meteorological Department)

4.1.2 Physiography and Geology¹⁴

Ernakulam district can be broadly divided into three physiographical units viz.

- the Coastal plains (lowlands) - entire taluks of Kochi and Parur and major parts of Kanayannur
- the mid lands - All the other taluks except the north-eastern parts of Kunnathunad taluk
- the high lands - Malayattoor reserve forest in Koovappady block (9% of the district area)

The Coastal belt is dotted with a host of islands ranging from largest Vypin islands of length 27 km to, smaller islands like Mulavukad, Vallarpadam, and Willingdon Island etc. The western coast of Vypin has the longest beach in Kochi namely, the Cherai Beach. The northern tip of Vypin (Munambam) has the largest fishing harbour in Kochi namely, the Munambam Fishing Harbour.

4.1.3 Drainage¹⁵

The Ernakulam district is drained by the Periyar and its tributaries in the north and Muvattupuzha River in the south. In the district the river takes almost a straight-line course roughly in a North Western direction and at near Bhuthathankettu dam, it is joined by major tributaries Cheruthoni and

¹⁴ CGWB's Ground Water Information Booklet of Ernakulam District (December 2013)

¹⁵ CGWB's Ground Water Information Booklet of Ernakulam District (December 2013)

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Idamalayar. Further downstream at Aluva, the river bifurcates into two: the Marthandavarma and the Mangalapuzha branches. The Mangalapuzha branch joins Chalakkudy river and empties into the Lakshadweep sea at Munambam, and the Marthandavarma branch flows southwards, through the Udyogamandal area and joins the Cochin backwater system (part of Vembanad Lake) at Varapuzha. The Periyar is a perennial river and is source of drinking water for several major towns. The Idukki dam across the Periyar generates a significant proportion of Kerala's electrical power.

The Muvattupuzha River is formed by the confluence of Thodupuzha River, Kaliyar River and Kothamangalam River at Muvattupuzha. These rivers originate from the Thodupuzha reserve forest. The Muvattupuzha River takes a rough east-west course up to Ramamangalam and thereafter it flows towards south leaving the districts south of Pazhur. In the upstream areas the drainage pattern in both Periyar and Muvattupuzha basin are trellis to sub-trellis. In the lower reaches dendritic pattern of drainage is observed.

The Metro phase I extension alignment passes through the Chambakkara canal on its way from Petta Junction to SN Junction. The project alignment as observed in Figure 4-5 passes through a major 5th order stream towards south east. Along with this the alignment passes also through one third order and one second order stream. Figure 4-5 outlines drainage pattern of the area.

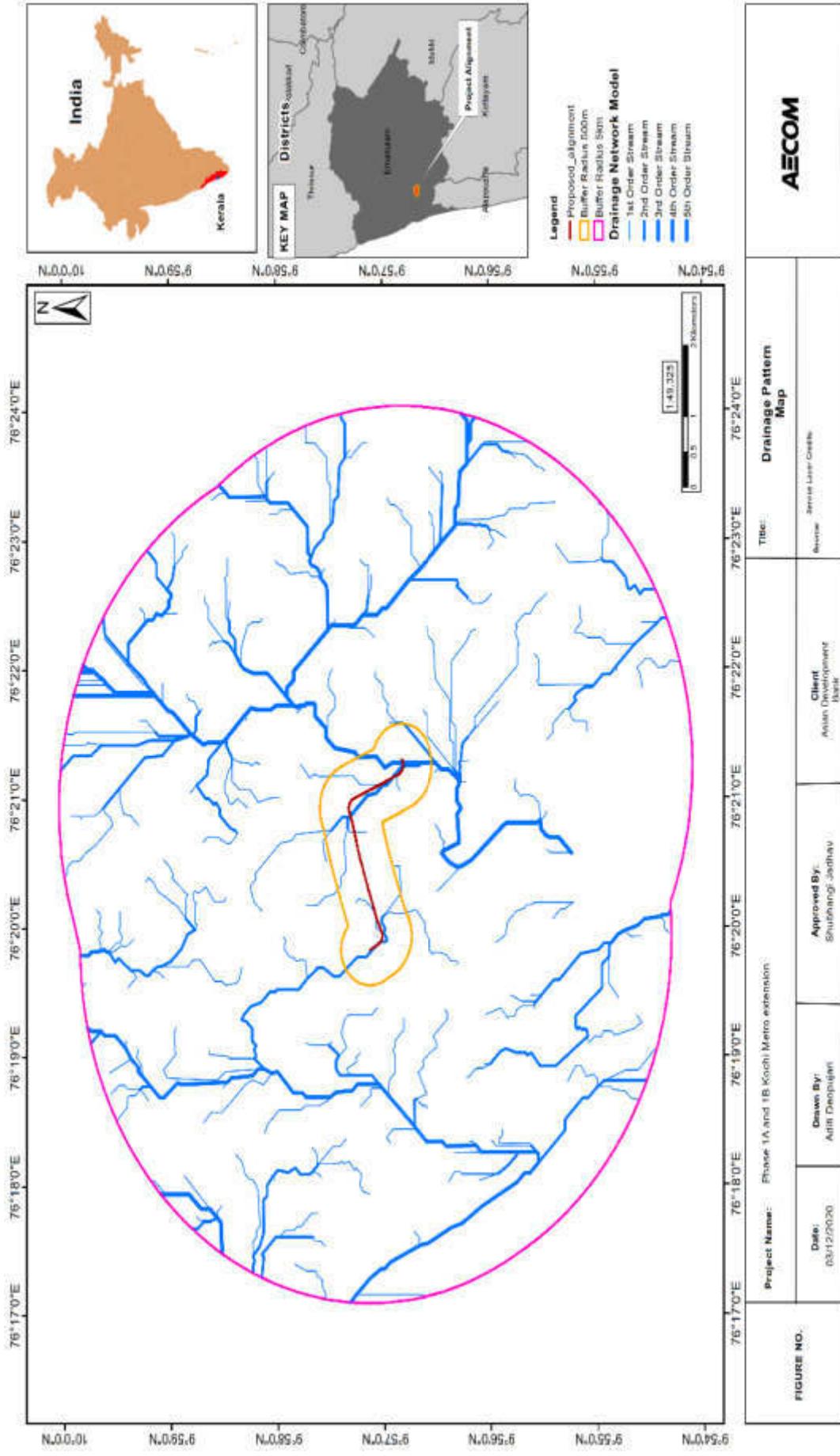


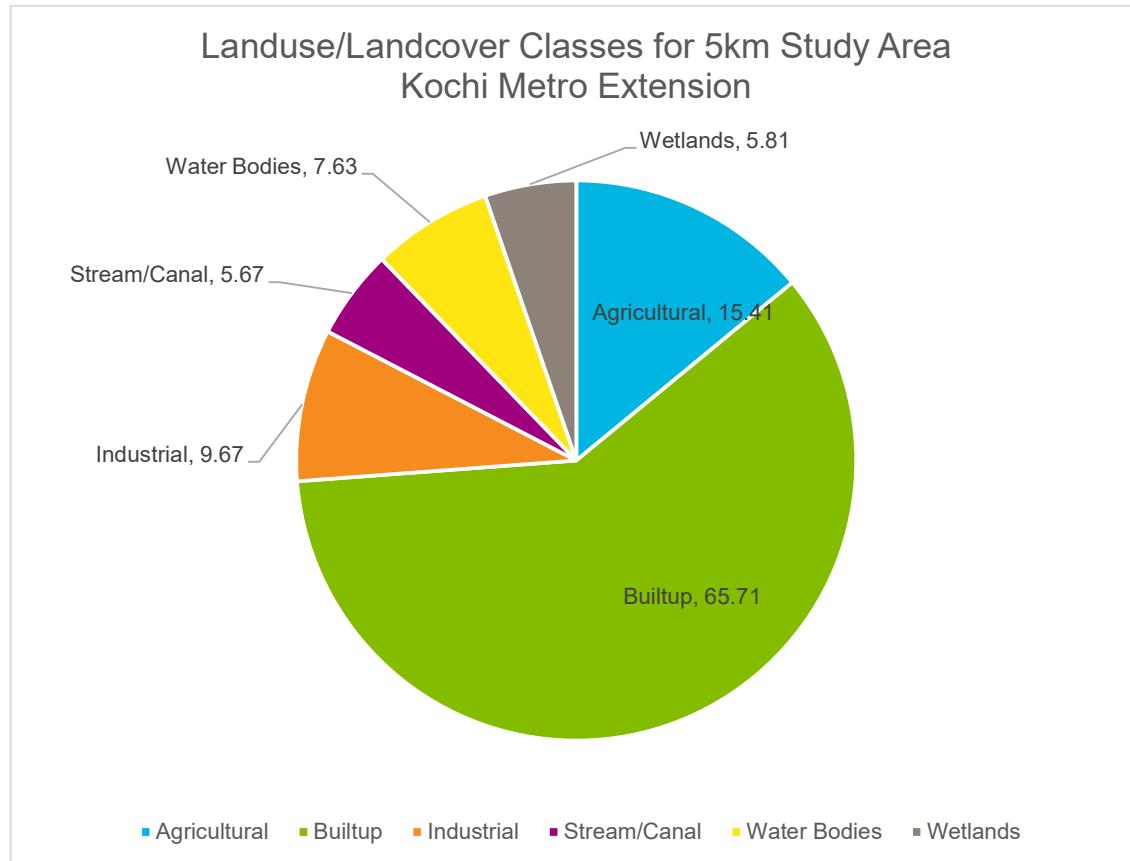
Figure 4-5: Drainage for Ernakulam District

4.1.4 Land use and Land Cover

About 60% of the total area of the district is Built-up area followed by 14% is agricultural land. Water bodies including streams and canals aggregate to constitute 12% and industrial area constitutes nearly 8% of the total area. The land use pattern of the district is given in Table 4-5 and Figure 4-6 below

Table 4-5: Land Use Pattern

Class	Total Area (sq.km)	Percent Area (%)
Agricultural	15.41	14.02
Built-up	65.71	59.79
Industrial	9.67	8.80
Stream/Canal	5.67	5.16
Water Bodies	7.63	6.94
Wetlands	5.81	5.29
Grand Total	109.90	100



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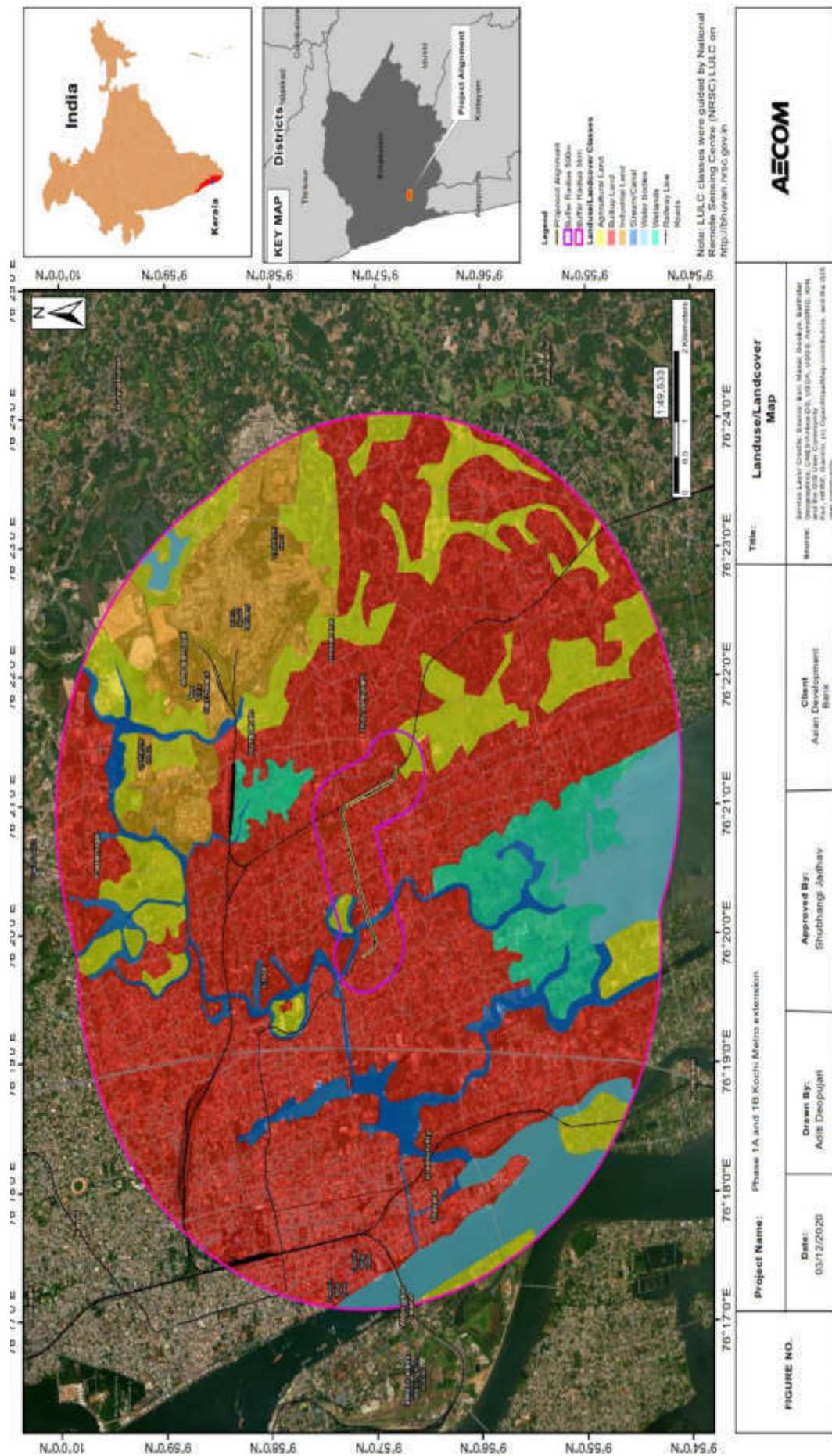


Figure 4-6: Land Use in Project Area

4.1.5 Hydrogeology

Groundwater generally occurs under phreatic conditions in weathered and fractured crystalline rocks, laterites and unconsolidated coastal sediments. It occurs under semi-confined to confined conditions in the deep-seated fractured aquifer of the crystalline rocks and Tertiary sediments. The weathered zone in the crystallines below acts as good storage for groundwater. Based on nature of formation, the aquifer can be classified into hard rock aquifers and sedimentary aquifers.

4.1.6 Hazard Areas for Project Site

Kerala state is vulnerable in varying degrees to a large number of natural disasters of recurrent nature that result in loss of life, livelihoods, infrastructure and property, and cause immense hardships to the affected population, besides resulting in disruption of economic activity.

Figure 4-7 outlines the Project alignment on a multiple hazard zonation map obtained from Kerala State Disaster Management Authority (Natural Hazard Zonation Map of Kerala (October 2014)). This map covers areas prone to coastal erosion, areas exposed to storm surge/ tsunami, areas prone to flood, epicentres of prior earthquakes, major faults/ lineaments, location of lightening incidents, areas prone to landslide, forest area and general administrative boundaries (taluka & village boundary, utilities, etc).

Based on Figure 4-7, it appears that other than flood plain zone, no other hazards are identified to be part of or in the immediate vicinity of the Project Site.

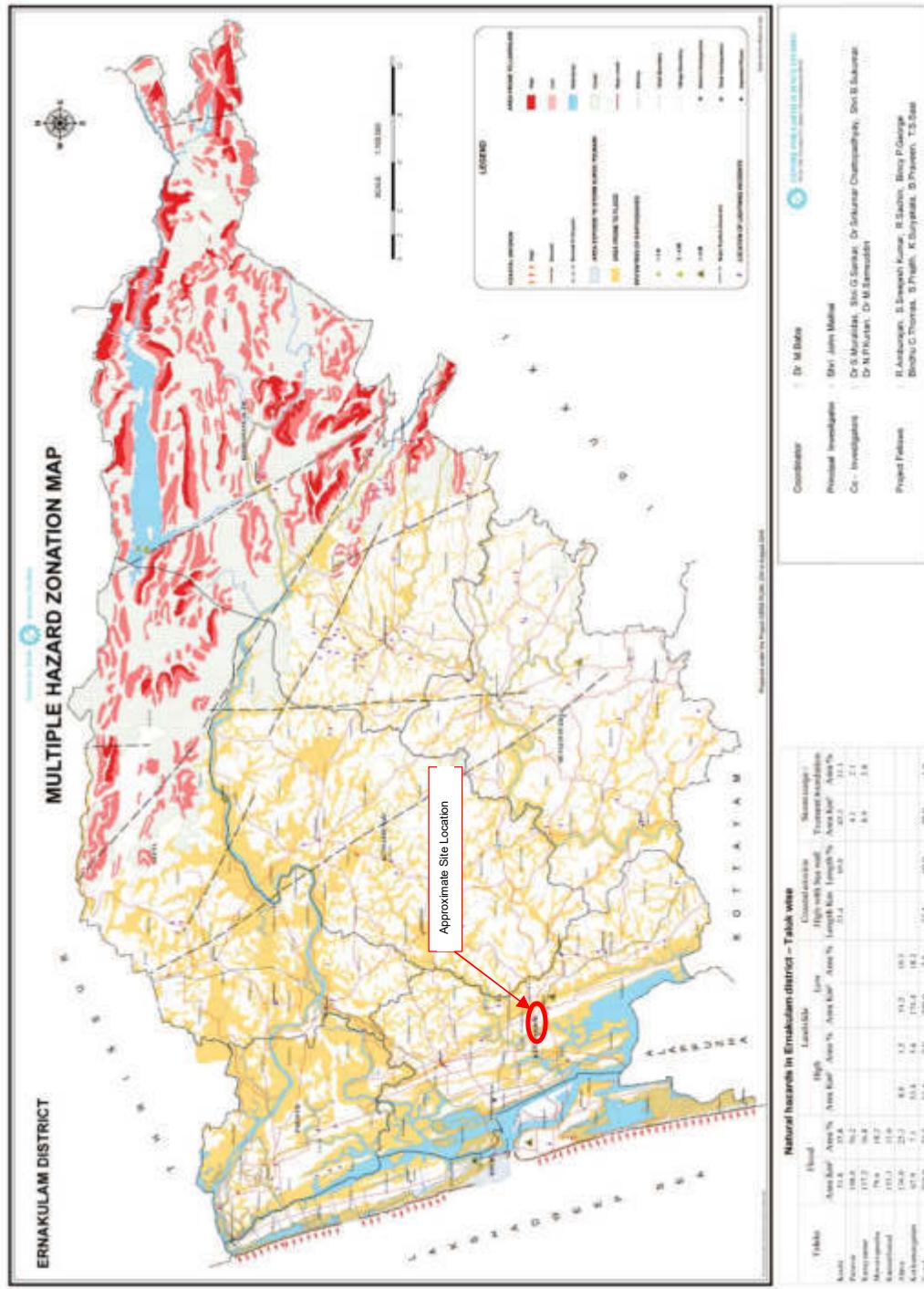


Figure 4-7: Multiple Hazard Zone of Ernakulam District

Source: Natural Hazard Zonation Map of Kerala (October 2014)

4.1.6.1 Flood Areas for Project Site

Figure 4-8 outlines the Project alignment on flood plain map obtained from Kerala State Disaster Management Authority portal. Based on this image, it appears that approximately 500m of the western portion of the alignment falls in the flood plain zone.



Figure 4-8: Flood Plain in Project Area

Source: Kerala State Disaster Management Authority Google Earth Imagery

4.1.6.2 Thunder and Lighting¹⁶

Occurrence of causalities during monsoon season has become a common issue in the district. Hence Ernakulam is considered as one of the thunders and lightning prone district of the state.

4.1.6.3 Cyclone¹⁷

The district witness's myriad of events of mild cyclone and associated destruction during monsoons, June – August (South west monsoon) and September – November (North east monsoon). Occasional influence of cyclonic storm during the south west monsoon seasons thus creates another dimension to the district's disaster profile.

4.1.6.4 Drought¹⁸

The district experiences severe water shortage crisis for drinking and agricultural purposes when there is a decline in the rainfall intensity during March to June. The situation is becoming severe in the recent years.

4.1.6.5 Wind Hazard

Majority of the state of Kerala lies in low damage risk zone with wind speed of less than 33 meter per second (m/s) as seen in the Figure 4-9 below.

¹⁶ DISTRICT DISASTER MANAGEMENT PLAN – ERNAKULAM 2015

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Figure 4-9: Wind Hazard map of India

Source: BMTPC, Third Edition (2019)

4.1.6.6 Seismicity

Past earthquakes were recorded from 200-2016 in the eastern portions of Ernakulam district as can be seen in the Figure 4-10 below. Project Site is considered to be located in Moderate risk area.

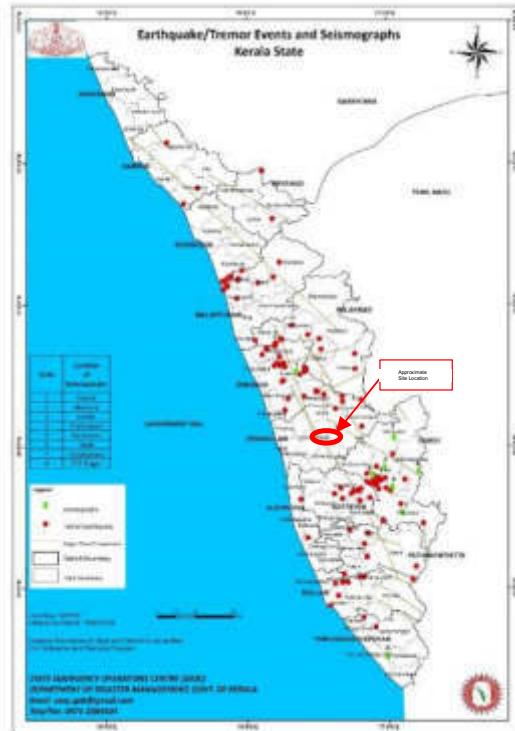


Figure 4-10: Earthquake Events of Kerala state

Source: Kerala State Emergency Operations Centre (SEOC)

4.2 Environmental Baseline

In order to evaluate the environmental quality in the study area, monitoring was carried out for twenty four (24) hours in the month of November 2020 by an external laboratory, M/s Poluchem Laboratories Private Limited, which is accredited to National Accreditation Board for Testing and Calibration Laboratories (NABL) in accordance with ISO/IEC 17025:2005 and as "A" Grade Laboratory by Kerala State Pollution Control Board (KSPCB).

4.2.1 Ambient Air Quality

Ambient air was monitored in the project area for 24 hours in the month of November (2020) to estimate the quality of ambient air around the project site. The air quality was analysed at two (02) locations to estimate the concentration of primary pollutants in the ambient air.

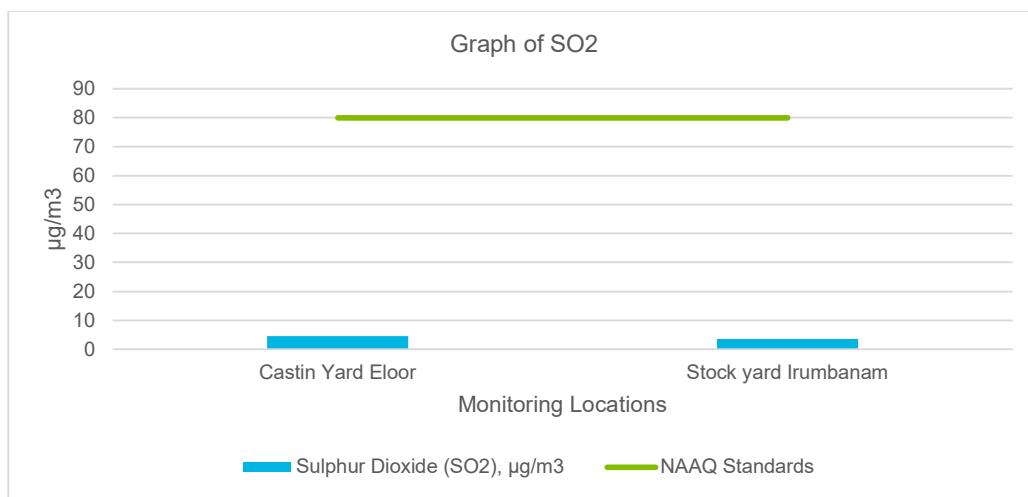
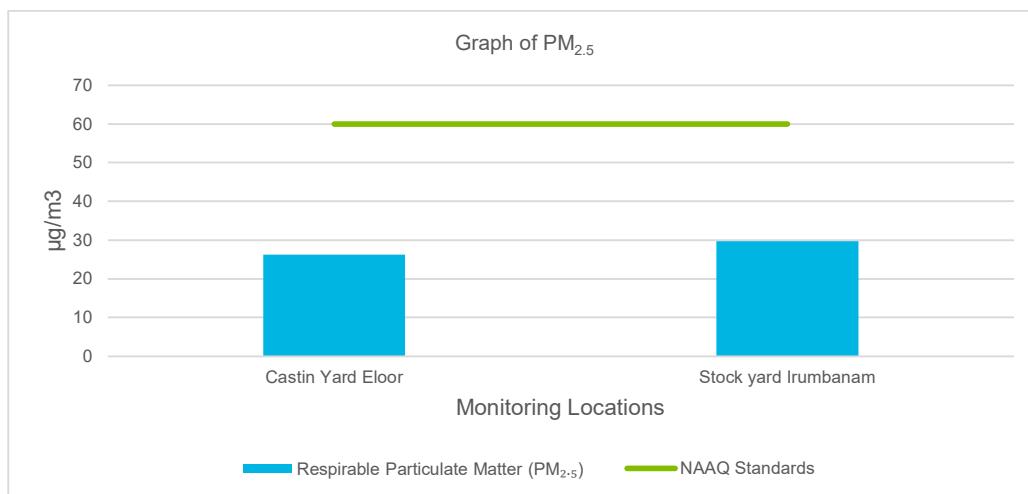
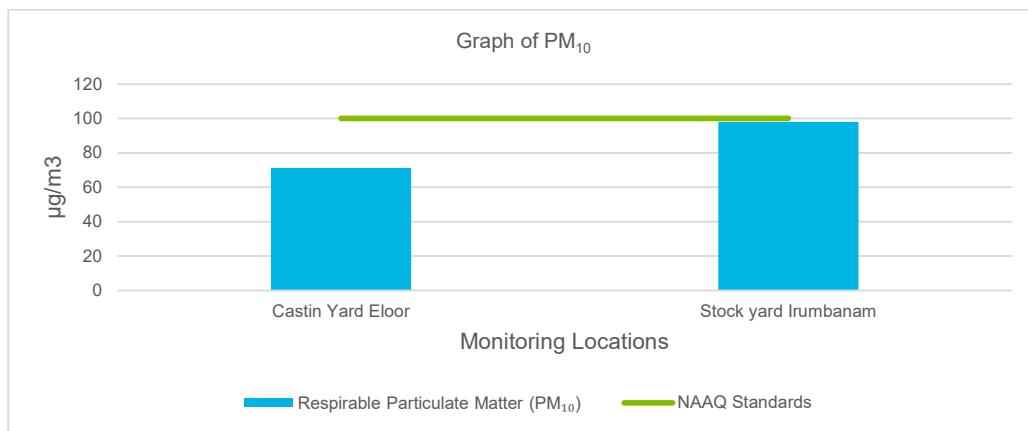
The ambient air quality results were compared to the National Ambient Air Quality Standards (NAAQS, 2009) for rural and residential area and the analysis results of air quality have been presented below in the Table 4-6. Graphs showing variation of each parameter are depicted in Figure 4-11 below.

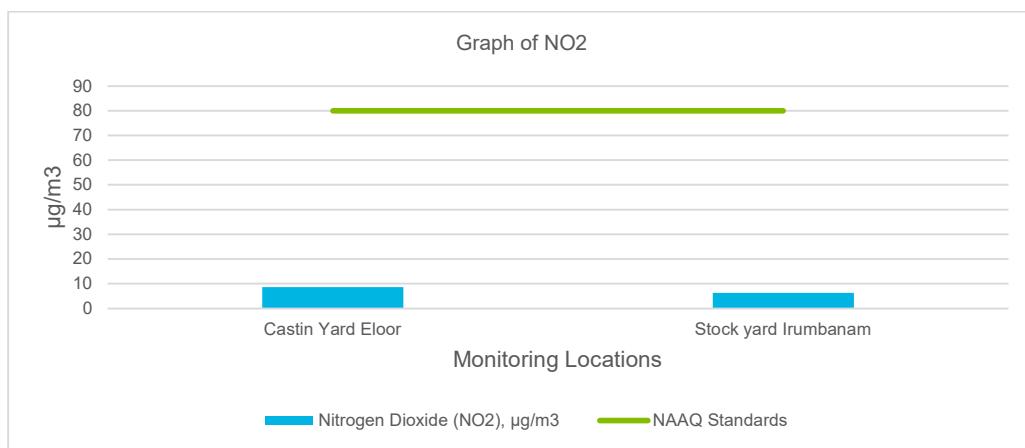
Table 4-6: Results of Ambient Air Monitoring

Parameter	Time Weighted Average	Concentration in Ambient Air (Industrial, Residential, Rural and Other Areas)	AAQ-1 Castin Yard Elloor	AAQ-2 Stock yard Irumpanam
Particulate Matter (size less than 10 μm) or PM ₁₀ , $\mu\text{g}/\text{m}^3$	24 Hours	100	71.2	98
Particulate Matter (size less than 2.5 μm) or PM _{2.5} , $\mu\text{g}/\text{m}^3$	24 Hours	60	26.3	29.8
Sulphur Dioxide (SO ₂), $\mu\text{g}/\text{m}^3$	24 Hours	80	4.6	3.6
Nitrogen Dioxide (NO ₂), $\mu\text{g}/\text{m}^3$	24 Hours	80	8.7	6.3
Carbon Monoxide (CO), mg/m ³	8 Hours	2	<1	<1
Lead (Pb), $\mu\text{g}/\text{m}^3$	24 Hours	1	<0.1	<0.1
Arsenic (As), ng/m ³	Annual	6	<0.5	<0.5
Nickel (Ni), ng/m ³	Annual	20	<0.5	<0.5
Ozone (O ₃), $\mu\text{g}/\text{m}^3$	8 Hours	100	<1	<1
Benzene (C ₆ H ₆), $\mu\text{g}/\text{m}^3$	Annual	5	<0.1	<0.1
Benzo (O) Pyrene (BaP), particulate phase only, ng/m ³	Annual	1	<0.1	<0.1
Ammonia (NH ₃), $\mu\text{g}/\text{m}^3$	24 Hours	400	<0.1	<0.1

Source: Laboratory Results, November 2020

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DRAFT**Figure 4-11: Graphical representation of Ambient Air values in Project Area****Inference**

The project site is situated in an urban setting with multiple emission sources within 5 km radius of the Project Site. The parameters measured for ambient air quality were noted to be within the permissible limits of the National Ambient Air Quality Standards (NAAQS), as defined by MoEF&CC. PM_{2.5}, PM₁₀, SO₂, and NO₂ were detected in all the samples but were noted to be well within the permissible limits, while other parameters like CO, Pb, As, Ni, O₃, C₆H₆, Benzo (O) Pyrene (BaP), NH₃, were not detected at any of the locations.

4.2.1.1 Ambient Air Quality as monitored by KEC-CCECC

Ambient air quality is monitored by KEC-CCECC in the project area for 24 hours once every month to estimate the quality of ambient air around the project site. This has been presented here as secondary information for the project. The air quality was analysed at four (04) locations to estimate the concentration of primary pollutants in the ambient air.

The ambient air quality results were compared to the National Ambient Air Quality Standards (NAAQS, 2009) for rural and residential area and the analysis results of air quality have been presented below in the Table 4-7. Graphs showing variation of each parameter are depicted in Figure 4-12 below.

Table 4-7: Results of Ambient Air Monitoring (As Monitored by KEC-CCECC)

Locations	Month (year 2020)	Particulate Matter (size less than 10 µm) or PM ₁₀ , µg/m ³	Particulate Matter (size less than 2.5 µm) or PM _{2.5} , µg/m ³	Sulphur Dioxide (SO ₂), µg/m ³	Nitrogen Dioxide (NO ₂), µg/m ³	Carbon Monoxide (CO), mg/m ³
NAAQS		100	60	80	80	4
Pettah	August	65.1	23.4	3.98	5.09	1.25
	September	60.2	18.8	3.99	5.2	1.3
	October	96.4	39.1	4.57	5.39	1.39
SN Junction	August	62.4	30.9	3.99	8.1	1.5
	September	68.1	25.5	4.2	5.3	1.3
	October	90.2	37.9	4.97	5.43	1.41
Irumpanam m (steel yard)	August	70.1	31.7	4.15	6.49	1.25
	September	71.2	25.3	4.2	6.3	1.15
	October	94.5	38.6	4.36	6.79	1.34
Kalamasser y (Pre -cast yard)	August	75.7	30.2	<2	<2	<1.15
	September	73.3	29.4	<2	<2	<1.15
	October	116	49.8	<2	<2	<1.15



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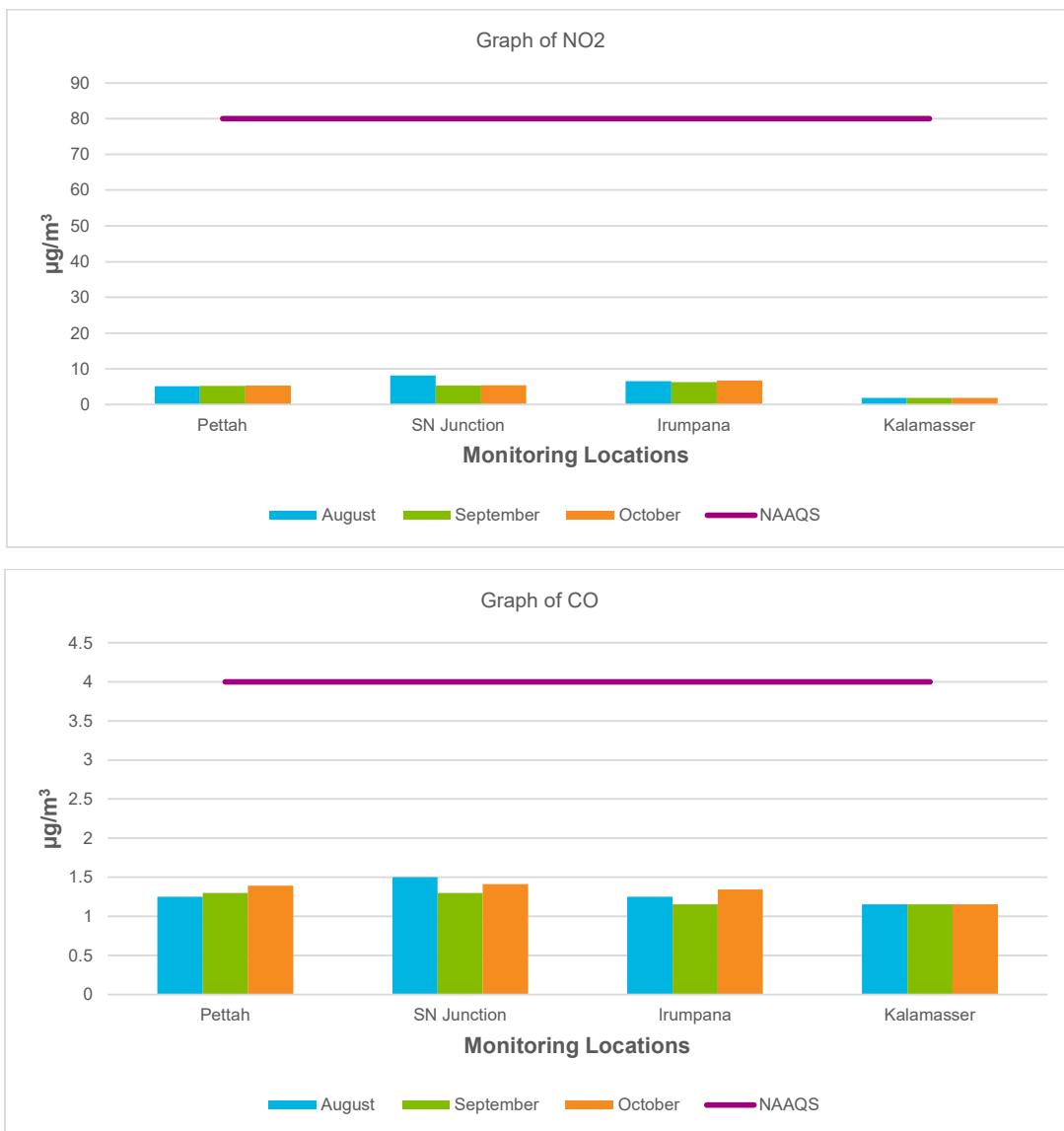


Figure 4-12: Graphical representation of Ambient Air Quality

Inference

The parameters measured for ambient air quality were noted to be within the permissible limits of the National Ambient Air Quality Standards (NAAQS), as defined by MoEF&CC. PM2.5, PM10, SO₂, and NO₂ were detected in all the samples but were noted to be well within the permissible limits, except PM10 at Kalamassery (Pre -cast yard), which was slightly above the permissible limit in October 2020. The one-time exceedance maybe attributed to construction activities being carried out.

4.22 Ambient Noise Quality

Ambient noise level was monitored continuously for 24 hours at eight (08) locations along the alignment using Sound Level Meter at the identified receptor locations mentioned in Table 4-2. The noise levels obtained were analysed to arrive at the equivalent continuous noise level (L_{eq}) for day and night-time. The day and night-time hours ranged from 06:00 to 22:00 hrs and 22:00 to 06:00 hrs respectively.

The sampling locations can be categorised as Silence Zone, Commercial area and Industrial area. Therefore, the results of the ambient noise level monitoring presented in Table 4-8 are compared with National Ambient Air Quality Standards (NAAQS) in respect of noise limits for daytime and night-time for corresponding areas.

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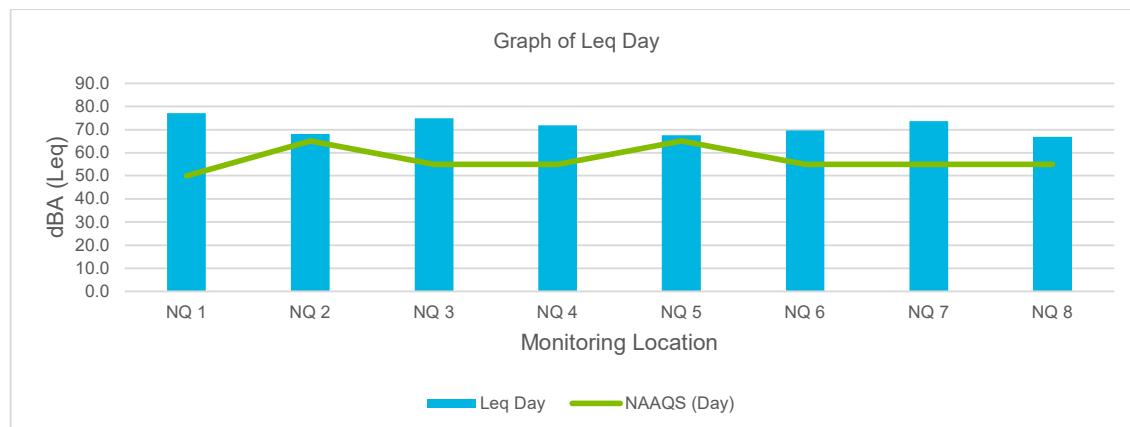
Table 4-8: Results of Ambient Noise level Monitoring

NAAQS									
Location Code	Location	Zone	Daytime (Ldn) dB (A)	Night-time dBA (Leq)	day Time dBA (Leq)	Night-Time dBA (Leq)	Lmin	Lmax	Leq
NQ 1	Near Petta Mosque	Silence Zone	50.0	40.0	77.1	76.5	73.8	78.5	76.9
NQ 2	Golden Fork	Commercial	65.0	55.0	68.2	63.6	54.2	72.6	67.3
NQ 3	Proposed Vadakkekotta Station	Residential	55.0	45.0	74.9	74.5	73.7	76.6	74.8
NQ 4	SN-Junction	Residential	55.0	45.0	71.8	71.7	68.7	74.4	71.8
NQ 5	Under FOB Near Milma Dairy'	Commercial	65.0	55.0	67.7	60.2	59.3	77.2	66.5
NQ 6	Tripunithura Station	Residential	55.0	45.0	69.6	69.7	55.0	75.5	69.7
NQ 7	Eloor Casting Yard	Residential	55.0	45.0	73.6	72.7	71.7	75.0	73.3
NQ 8	Irumpanam Stock Yard	Residential	55.0	45.0	66.8	67.2	66.1	67.7	66.9

Source: Laboratory Results, November 2020

Inference

The ambient noise levels at all eight locations along the alignment i.e. NQ 1 to NQ 8. were noted to be exceeding the permissible standards of noise levels prescribed by CPCB for daytime and night-time. The high noise level can be attributed to vehicular movements, drilling work being undertaken nearby the site etc. The exceedance at the stock yard and casting yard could be attributed to high noise machine operations at work and night-time transportation of the precast viaducts to the site.



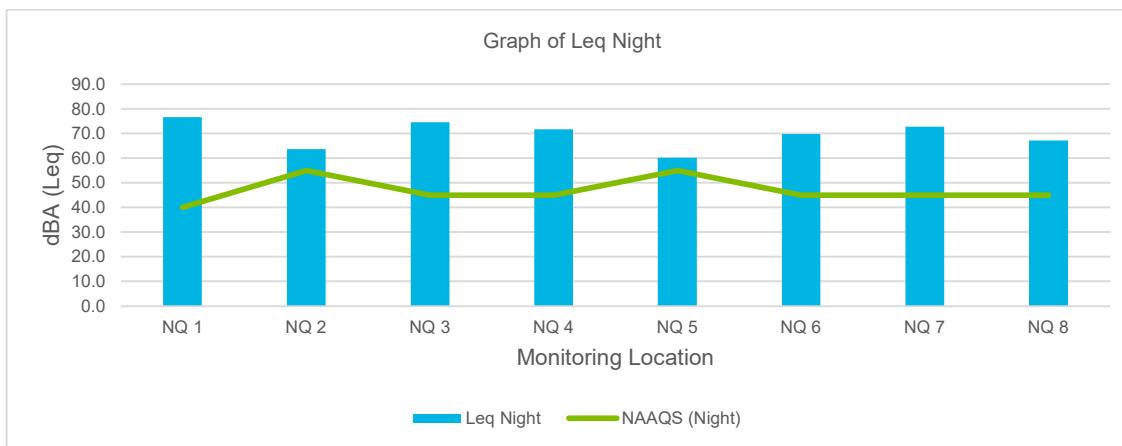
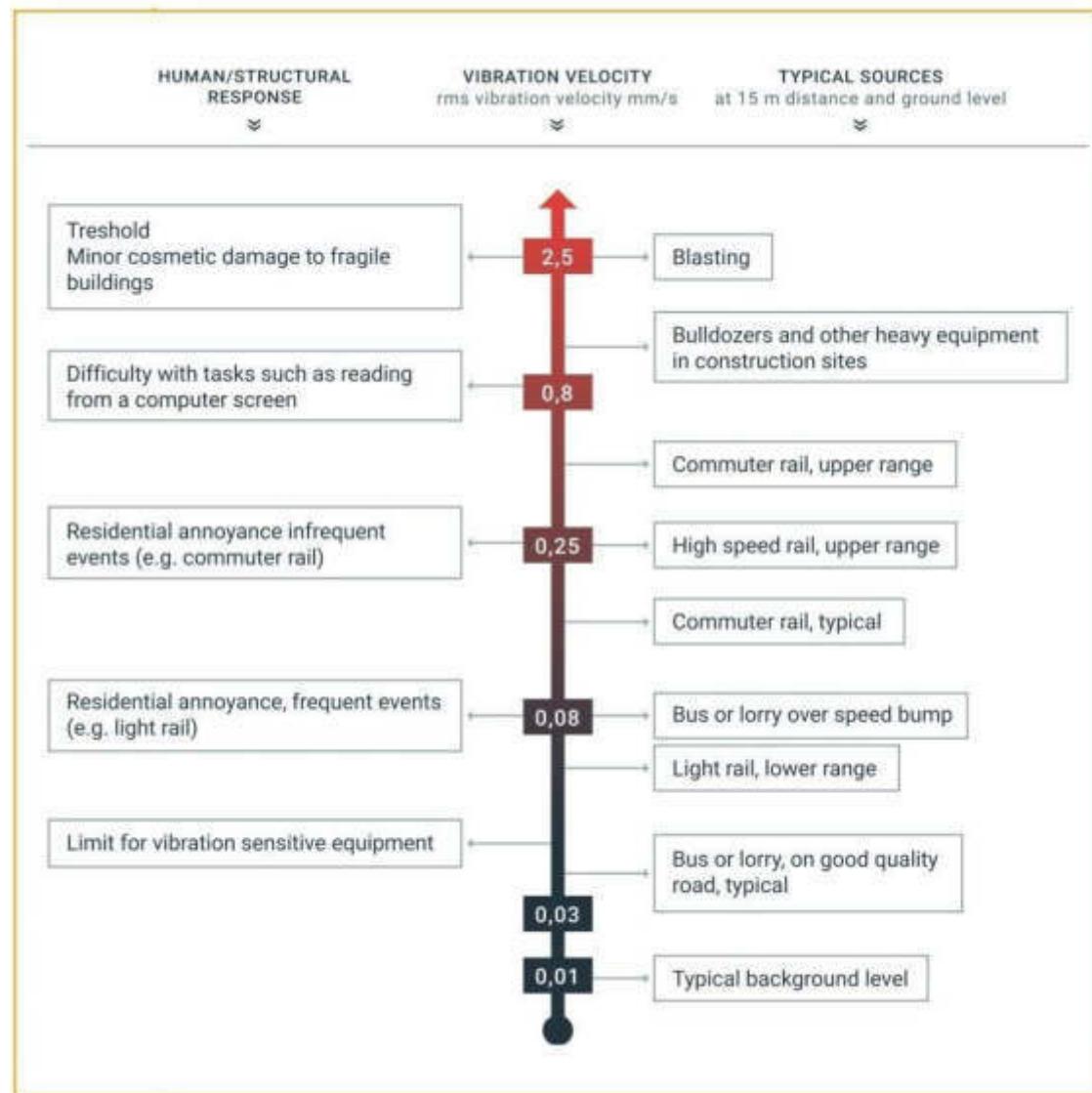


Figure 4-13: Graphical Representation of the Noise Levels

4.2.3 Vibration

Ground vibrations are produced whenever there is moving load or impact on the ground. Main source of ground vibrations is traffic including rail and road, pile driving, rock blasting, movement of construction machinery are some activities that typically contribute to vibration levels. Except at lower levels, ground vibrations do not have any impact on the human beings or on the structures. Higher levels, vibrations can cause structural damage. Typical activities contributing to vibration impact are depicted below in Figure 4-14.

**Figure 4-14: Typical sources of vibration and impacts**

Baseline vibration levels were measured at 6 locations for a period of twenty-four (24) hours. The six locations were spread across the total length of the corridor of 3km within 1 or 2m from the live traffic from Petta to Tripunithura Railway Station.

Ground vibrations depend on the force (impact) of the source and the distance that decreases with the distance.

$$V \propto Q/D$$

where V is the vibrations, Q is the impact, and D is the distance from the source to the point of observation.

Ground vibrations due to traffic are generally less than the perceptible limits and people living in the vicinity usually get acclimatized soon.

Vibrations produced by rail movement are easy to control by use of better cushioning materials, better quality sleepers and absorbent materials if vibrations are very high. India has no specified limits for this kind of vibrations. Limits for ground vibrations in India are covered by the Director General of Mines Safety in circular number 7 of 1997.

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Since road traffic is a continuous one, the structure around it is subjected to ground vibrations continuously, vibration limits applicable to mines where problem is high are not suitable for continuous vibrations like that of from road traffic. Hence vibration limits specified in DIN (**Deutsches Institut** (German Institute for Standardization)) specifications have been suggested for comparison of the results.

Table 4-9: Din Table (Guideline values for vibration velocity to be used when evaluating effects of short-term vibration on structures)

Line	Type of Structure	Guideline values for velocity, V_v in mm/s Vibration at foundation at frequency of			Vibration at horizontal plane of highest floor at all frequencies
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	
1.	Buildings used for commercial purposes, industrial building and buildings of similar design	20	20 to 40	40 to 50	40
2.	Dwellings and buildings of similar design and/ or occupancy	5	5 to 15	15 to 20	15
Structures that because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)			3	3 to 8	8 to 10
3.					8

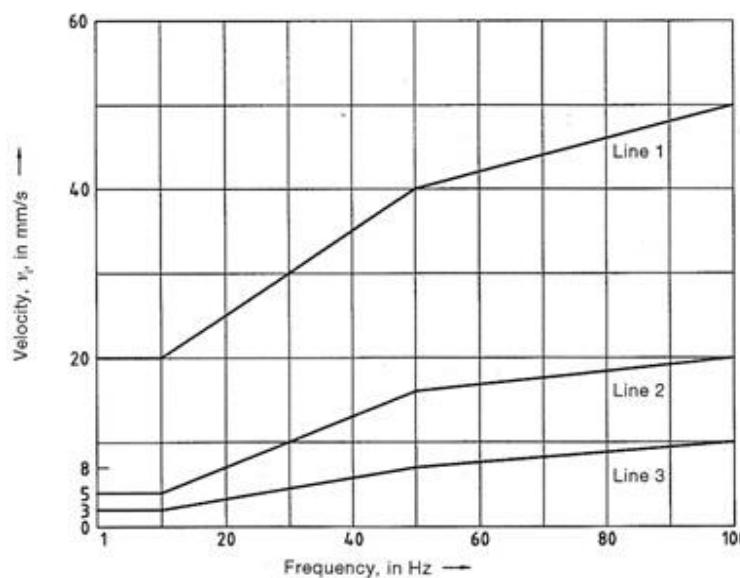


Figure 4-15: Curves for guideline values specified in above table for velocities measured at the foundation

Table 4-10: Results of Vibration Monitoring

Location Code	Location Name	Date	MIN PPV (mm/s)	TIME (hr)	MAX PPV (mm/s)	TIME (hr)
VB 1	Majid beside Chembakkara Canal	05-11-2020	0.254	01:15:42	4.826	03:18:03
VB 2	Near Golden Fork Hotel	06-11-2020	0.127	04:07:38	2.921	19:36:27
VB 3	OPP. HP Petrol Pump	07-11-2020	0.254	02:21:39	3.175	23:08:34
VB 4	Central Bank of India	08-11-2020	0.127	02:16:41	2.794	12:39:16
VB 5	Under ROB Near Milma Dairy	08-11-2020	0.254	00:02:18	5.588	15:06:53
VB 6	Near Tripunithura Railway Station	09-11-2020	0.254	07:13:33	1.016	16:52:15

DRAFT**Inference**

Based on results of Vibration monitoring (Table 4-10) and guidance for vibration velocity table indicated above, it appears that the vibration velocity at all locations is well within the vibration limits specified in DIN specifications. Vibration limits at residential areas such as VB 1 to VB4 and VB6 fall within the recommended standards for dwellings and buildings of similar occupancy (5 mm/s). vibration levels measured at Milma diary is classified as "commercial" and the maximum vibration velocity recorded here too is less than that recommended for commercial establishments (20 mm/s).

4.2.4 Water Quality**4.2.4.1 Drinking Water**

Two (02) drinking water samples were collected to assess the water quality at the two labour camps. Water samples were examined for physico-chemical, heavy metals and biological parameters as per standard testing procedures and compared to Drinking Water Standards, IS 10500: 2012.

Table 4-11 presents the results of analysis of the drinking water sample which are compared with acceptable limits as specified in the drinking water standards IS 10500:2012.

Table 4-11: Results of Drinking water Monitoring

Parameters tested	Test method	IS-10500-2012 Limit (Acceptable Limits)	Casting Yard- Eloor	Stock Yard- Irumpanam
pH	IS 3025 (P) 11-1983RA2017	6.5 – 8.5	5.9	6.8
Color	IS 3025 (P) 11-1983RA2017	5 Hazen Unit	4	3
Odour	IS 3025 (P) 11-1983RA2017	Agreeable	Agreeable	Agreeable
Turbidity	IS 3025 (P) 11-1983RA2017	1 NTU	BDL(MDL-1 NTU)	BDL(MDL-1 NTU)
Total Dissolved Solids	IS 3025 (P) 11-1983RA2017	500 mg/l	97.5 mg/l	85.8 mg/l
Total Hardness as CaCO ₃	IS 3025 (P) 11-1983RA2017	200 mg/l	24 mg/l	28 mg/l
Calcium as Ca	IS 3025 (P) 11-1983RA2017	75 mg/l	5.61 mg/l	7.21 mg/l
Magnesium as Mg	IS 3025 (P) 11-1983RA2017	30 mg/l	2.43 mg/l	2.43 mg/l
Total Alkalinity as CaCO ₃	IS 3025 (P) 11-1983RA2017	200 mg/l	BDL(MDL-1mg/l)	6.63 mg/l
Chloride as Cl-	IS 3025 (P) 11-1983RA2017	250 mg/l	24.1 mg/l	21.21 mg/l
Sulphate as SO ₄	IS 3025 (P) 11-1983RA2017	200 mg/l	4.15 mg/l	3.15 mg/l
Iron as Fe	IS 3025 (P) 11-1983RA2017	0.3 mg/l	BDL(MDL-0.05mg/l)	BDL(MDL-0.05mg/l)
Residual Chlorine	IS 3025 (P) 11-1983RA2017	Min 0.2 mg/l	BDL(MDL-0.1mg/l)	BDL(MDL-0.1mg/l)
Nitrate as NO ₃	IS 3025 (P) 11-1983RA2017	45 mg/l	BDL(MDL-1mg/l)	7.42 mg/l
Fluoride as F	IS 3025 (P) 11-1983RA2017	1.0 mg/l	BDL(MDL-0.1mg/l)	BDL(MDL-0.1mg/l)
Total Chromium as Cr	IS 3025 (P) 11-1983RA2017	0.05 mg/l	BDL(MDL-0.02mg/l)	BDL(MDL-0.02mg/l)
Coliforms	IS 1622: 1981RA2009	Shall not be detectable in any 100 ml sample	Absent	Absent
E coli	IS 1622: 1981RA2009	Shall not be detectable in any 100 ml sample	Absent	Absent
Aluminium as Al	IS 3025 (P) 55 –2003RA2014	0.03 mg/l	BDL(MDL-0.02mg/l)	BDL(MDL-0.02mg/l)
Molybdenum as Mo	IS 3025(P)2-2003 RA 2017	0.07 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Selenium as Se	IS 3025 (P)56 –2003RA2016	0.01 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)

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Parameters tested	Test method	IS-10500-2012 Limit (Acceptable Limits)	Casting Yard- Eloor	Stock Yard- Irumpanam
Silver as Ag	IS 13428:2005	0.1 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Nickel as Ni	IS 3025(P) 54– 2003RA2014	0.02 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Cadmium as Cd	IS 3025(P) 41– 1992RA2014	0.003 mg/l	BDL(MDL-0.001mg/l)	BDL(MDL-0.001mg/l)
B O D (3 days at 270 C)	IS 3025 (P) 44-1993 RA2014	---	<1 mg/l	<1 mg/l
C O D	IS 3025 (P) 58-2006 RA2017	---	4 mg/l	8mg/l
Phosphorus as P	IS 3025 (P) 31-1988 RA2014	---	BDL(MDL-0.1 mg/l)	BDL(MDL-0.1 mg/l)
Lead as Pb	IS 3025(P) 47-1994RA2014	0.01 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Copper as Cu	IS 3025(P) 42-1992RA2014	0.05 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Manganese as Mn	IS 3025(P) 59-2006RA2017	0.1 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Mercury as Hg	IS 3025(P) 48-1994RA2014	0.001 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Zinc as Zn	IS 3025(P) 48-1994RA2014	5.0 mg/l	0.02 mg/l	0.02 mg/l
Total Arsenic as As	IS 3025(P) 48-1994RA2014	0.01 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Barium as Ba	IS 13428:2005	0.7 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Boron as B	IS 3025(P) 57– 2005RA2017	0.5 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Chloramines as Cl2	APHA 4500 Cl F	4.0 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Ammonia as Total ammonia N	IS 3025(P)34-1988 RA 2017	0.5 mg/l	BDL(MDL-0.05mg/l)	BDL(MDL-0.05mg/l)
Anionic detergents as MBAS	IS 13428:2005	0.2 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Sulphide as H2S	IS 3025(P)29-1986RA2014	0.05 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Cyanide as CN	IS 3025(P)27-1986RA2014	0.05 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Mineral Oil	IS 3025(P)39-1991RA2014	0.5 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Total Pesticides	USEPA 515.1	----	BDL(MDL-0.025 µg /l)	BDL(MDL-0.025 µg /l)

BDL- Below Detection Level

MDL- Minimum Detection Level

Inference

The pH value of the sample at the Eloor Casting yard accounting for 5.9 was observed to be lower than the acceptable limits of 6.5, indicating slightly acidic in nature. Coliform and E.Coli were observed to be absent at all locations. All other parameters were either within the permissible limit or below detection level, indicating that the drinking water was fit for human consumption, once it is treated for high pH.

4.2.4.2 Surface Water

Two (02) surface water samples were collected to assess the water quality upstream and downstream of the Chembakkara canal. Water samples were examined for physico-chemical, heavy metals and biological parameters.

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Table 4-12 presents the results of analysis of the drinking water sample which are compared with acceptable limits as specified in the drinking water standards IS 10500:2012.

Table 4-12: Results of Surface water Quality Monitoring

Parameters tested	IS – 10500 – 2012 (Acceptable Limits)	North Side	South Side
pH	6.5 – 8.5	6.48	6.42
Color	5 Hazen Unit	17	60
Odour	Agreeable	Disagreeable	Disagreeable
Turbidity	1 NTU	5 NTU	51 NTU
Total Dissolved Solids	500 mg/l	5900 mg/l	5700 mg/l
Total Hardness as CaCO ₃	200 mg/l	740 mg/l	740 mg/l
Calcium as Ca	75 mg/l	104.20 mg/l	80.16 mg/l
Magnesium as Mg	30 mg/l	116.64 mg/l	131.22 mg/l
Total Alkalinity as CaCO ₃	200 mg/l	48.62 mg/l	48.62 mg/l
Chloride as Cl-	250 mg/l	3181.99 mg/l	2073.11 mg/l
Sulphate as SO ₄	200 mg/l	115.03 mg/l	111.89 mg/l
Iron as Fe	0.3 mg/l	0.42 mg/l	1.15 mg/l
Residual Chlorine	Min 0.2 mg/l	BDL(MDL-0.1mg/l)	BDL(MDL-0.1mg/l)
Nitrate as NO ₃	45 mg/l	23.78 mg/l	24.35 mg/l
Fluoride as F	1.0 mg/l	0.6 mg/l	0.65 mg/l
Total Chromium as Cr	0.05 mg/l	BDL(MDL-0.02mg/l)	BDL(MDL-0.02mg/l)
Coliforms	Shall not be detectable in any 100 ml sample	500 MPN/100ml	900 MPN/100ml
E coli	Shall not be detectable in any 100 ml sample	Present /100ml	Present/100ml
Aluminium as Al	0.03 mg/l	BDL(MDL-0.02mg/l)	BDL(MDL-0.02mg/l)
Molybdenum as Mo	0.07 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Selenium as Se	0.01 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Silver as Ag	0.1 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Nickel as Ni	0.02 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Cadmium as Cd	0.003 mg/l	BDL(MDL-0.001mg/l)	BDL(MDL-0.001mg/l)
B.O.D (3 days at 27°C)	---	10.3 mg/l	9.8 mg/l
C O D	---	160 mg/l	210 mg/l
Phosphorus as P	---	0.07 mg/l	0.66 mg/l
Lead as Pb	0.01 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Copper as Cu	0.05 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Manganese as Mn	0.1 mg/l	0.07mg/l	BDL(MDL-0.01mg/l)
Mercury as Hg	0.001 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Zinc as Zn	5.0 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Total Arsenic as As	0.01 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Barium as Ba	0.7 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Boron as B	0.5 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Chloramines as Cl ₂	4.0 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Ammonia as Total ammonia N	0.5 mg/l	1.47 mg/l	0.85 mg/l
Anionic detergents as MBAS	0.2 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Sulphide as H ₂ S	0.05 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Cyanide as CN	0.05 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Mineral Oil	0.5 mg/l	BDL(MDL-0.01mg/l)	BDL(MDL-0.01mg/l)
Total Pesticides	----	BDL(MDL-0.025 µg /l)	BDL(MDL-0.025 µg /l)
Polychlorinated biphenyls	0.0005 mg/l	BDL(MDL-0.0002mg/l)	BDL(MDL-0.0002mg/l)

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Parameters tested	IS – 10500 – 2012 (Acceptable Limits)	North Side	South Side
Phytoplakton		Navicula, Planktospaeria, Ulva, Fragilaria, Pinularia, Synedra, Spirulina, Palmella, Chromulina, Anacystis, Oocystis, Cryptomonas, Euglena, Botryococcus	Navicula, Spirulina, Stigeoclonium, Microcystis, Tetraedron, Phormidium, Cladophora, Scenedesmus, Diatoms, Ulothrix

Inference

The pH of surface water sample was within acceptable range. Odour was disagreeable. Total Hardness (As CaCO₃) and alkalinity were in the range of 740mg/l. Total Coliform was present in low numbers. As per the CPCB Surface water quality criteria, the surface water falls under **Class C** which signifies Drinking water source after conventional treatment and disinfection. Mineral oil was not found. Pesticides were not found. Many metals such as Al, Mn, Ni, Cu, Boron, As, Se, Mo, Cd, Ba and Hg were below detection limit.

4.2.5 Soil Environment

4.2.5.1 Soil Types

Soils of the district are classified as Lateritic, Hydromorphic saline, Brown hydromorphic, Riverine alluvium and Coastal alluvium. Lateritic soil is the most predominant soil type of the district. In Muvattupuzha, Kothamangalam, Kunnamkulam and parts of Aluva taluks lateritic soil is encountered. These soils are well drained, low in organic matter and plant nutrients. Small patches of hydromorphic saline soil are encountered in the coastal tracts of the district in Kanayannur and Kochi taluk. Brown hydromorphic soil is the second most prevalent soil type of the district and they are encountered in valley bottoms. The soil is enriched in clay content and plant nutrients. Riverine alluvium is restricted to the banks of rivers and their tributaries and are composed of sandy to clayey loam. In Kochi taluk and the western parts of Paravur and Aluva taluk coastal alluvium is encountered and is composed of sand and clay.

4.2.5.2 Soil Baseline Quality

Soil quality were accessed in the previous EIA report ¹⁹as well as testing carried out by KEC-CCECC. This has been presented here as secondary information for the project.

Details of the results are depicted in Table 4-13.

Table 4-13: Soil Sampling results²⁰

The soil samples were examined by KEC-CCECC through a laboratory for various physicochemical parameters, to determine the existing soil characteristics of the study area. Soil samples were collected from Tripunithura Railway Station. Soil Quality analysis summary is included in Table 4-14 below.

Table 4-14: Physiochemical Characteristics of Soil²¹

Sr. no.	Parameters	Unit	Tripunithura Railway Station
Physical Characteristics			
1.	Color	-	22
2.	Texture	USDA	46
3.	Particle Size Distribution		32

¹⁹ Environmental Impact Assessment Report for Kochi Metro Phase 1 Extension from Petta to Thripunithura, Kochi, dated July 2019

²⁰ Environmental Impact Assessment Report for Kochi Metro Phase 1 Extension from Petta to Thripunithura, Kochi, dated July 2019

²¹ Environmental Impact Assessment Report for Kochi Metro Phase 1 Extension from Petta to Thripunithura, Kochi, dated July 2019

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Sr. no.	Parameters	Unit	Tripunithura Railway Station
i.	Sand (0.02 to 0.20-mm)	%	48.6
ii.	Silt (0.002 to 0.02-mm)	%	1.36
iii.	Clay (< 0.002-mm)	%	29.6
4.	Porosity	%	48.6
5.	Bulk Density (BD)	Gm/cc	1.36
6.	Water Holding Capacity (WHC)	%	29.6
7.	Permeability	Cm/hr	0.4
Chemical Characteristics			
8.	pH (at 250C)	1:2 suspension	6.76
9.	Conductivity (EC)	µmhos/cm	415
10.	CEC	meq/100-gm	18.5
11.	Organic Matter	%	0.93
12.	Organic Carbon	%	0.54
13.	Copper as Cu	mg/Kg	0.62
14.	Zinc as Zn	mg/Kg	0.48
15.	Iron as Fe	mg/Kg	12.5
16.	Boron as B	mg/Kg	0.48
17.	Manganese as Mn	mg/Kg	6.25
18.	<i>Available Nutrients</i>		
i.	Nitrogen as N	Kg/ha	416.5
ii.	Phosphorus as P	Kg/ha	18.4
iii.	Potassium as K	Kg/ha	196.2

Excerpts from Former Kochi EIA Report⁶: Observations on Soil Quality

- **Physical Properties:** Study area comprised mainly of reddish-brown colour Clay Loam Soils. The Bulk Density (BD) of the soils was found in the 1.36 gm/cc. Water Holding Capacity (WHC) of study area soils was observed as 29.6%. Permeability values were found to vary from 0.40 cm/hr under Clay Loam textured soil in the study area.
- **Chemical Properties:** The soil pH was found as 6.76, thereby indicating the soil is neutral in nature. The organic carbon content was observed as 0.54% (0.93% as organic matter) thereby implying that soils are sufficient in organic content.
- **Macronutrients:** Available nitrogen content was observed in the surface soil as 416.5 kg/ha, thereby indicating that soil is medium in available nitrogen content. Available phosphorus content was observed as 18.4 kg/ha, thereby indicating that soil is medium in available phosphorus. Available potassium content in the sampled soil was also observed as 196.2 kg/ha, thereby indicating that the soil is medium in potassium content.
- **Micronutrients:** The available manganese content in sampled surface soil was recorded as 6.25 mg/kg, as the critical limit of available manganese is 2.0-mg/kg. The available Boron content in the sampled soil was found as 0.48-mg/kg. The critical limit for deficiency of the available Boron is 0.5-mg/kg.

4.2.6 Traffic

Kochi is connected to other parts of the country by all major modes of transport like road, rail, air and water. NH 17, NH 47 and NH 49; 3 National Waterways, an International Airport, Cochin Port located on strategic International Route and broad gauge railway lines link Kochi to other States. Kochi has seen increased urbanization over years requiring roads to be laid in incremental manners to cater all major traffic corridors.

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As per Kochi Metro's Detailed project report (DPR), registered vehicles in Ernakulam have increased from 8.9 to 17.6 Lakh in six years (2009-10 to 2016-17). This rapid increase in number of vehicles (10% p.a. in 3 years (2006-07 to 2009-10)) has worsened the transport situation. 10% of the vehicles in Ernakulam are cars and total registered vehicles in Ernakulam district in 2016-2017 are 1768869.

Excerpts from Former Kochi EIA Report²²: The analysis of mode wise growth of registered vehicles as given in DPR shows that the personalized mode of transport i.e. two wheelers and cars, have been growing tremendously with the annual increase of 9% and 14% respectively. The buses registered annual growth of 4% and auto rickshaws showed annual growth of 8%. Daily vehicular data at Petta bridge as given in City Mobility Plan Kochi and Development Plan for Kochi City Region 2031 is given in Table 4.19. Daily traffic as per the City Mobility Plan of Kochi between Vytilla to Petta Junction is 74,000 and PHPDT (Peak Hour Passenger Daily Traffic) is 10100 however as per DPR, PHDPT between Petta and Tripunithura is expected to be 4062 by 2031. Traffic data is listed in Table 4-15.

Table 4-15: Daily Vehicular Traffic in Project Area (2005)

Sr. No	Location	Road	2005 survey by NATPAC				Projected 2019			
			Inbound		Outbound		Total		Total	
			No	PCU	No	PCU	No	PCU	No	PCU
1.	Tripunithura road	Petta bridge	17,377	18,705	18,120	21,229	35,497	39,934	40,953	46,072

²² Environmental Impact Assessment Report for Kochi Metro Phase 1 Extension from Petta to Thripunithura, Kochi, dated July 2019

4.3 Biodiversity profile

This section describes the biodiversity profile of the Study Area in terms of species, habitats, designated areas and ecosystem services recorded in or reported from the Study Area.

4.3.1 Delineation of the Study Area

Geographically, the Study Area is situated in a section of the coastal plains of central Kerala, bounded by the floodplain of the Periyar River to the north and that of the Muvattupuzha River to the south. It is composed of the tidally influenced distributaries of these, as well as, many minor local rivers, along with their collective, largely stabilized, deltaic depositions. The terrain of the Study Area is nearly flat, with elevation ranging from approximately 2m to 8m. The land is drained mainly by a distributary of the Champakara River, known as the Champakara Canal, which empties into the Kochi backwaters, approximately 1.5 km south-southwest of the Study Area.

Ecologically, the Study Area represents a small part of the catchment of the Vembanad Kol Wetlands, an extensive system of deltaic landforms and backwaters interconnected by a network of natural, modified or anthropogenic canals. The inland wetlands of the Study Area represent freshwater aquatic ecosystems, while the section of the Champakara Canal situated within the Study Area represents a brackish water aquatic ecosystem. The habitat profile of the Study Area is dominated by modified habitats, while its species profile is dominated by species associated with urban habitation, as well as, coastal wetlands. The Champakara Canal, which drains into the northern part of the Kochi backwaters, forms the chief ecological connection between the Study Area and the aquatic habitats of the Vembanad Kol Wetlands, which, together with their catchment, are collectively designated as a Ramsar Site.

4.3.2 Methodology

This sub-section describes the methodology used for collecting or collating the primary and secondary data on which the biodiversity baseline of the Study Area is based.

The primary and secondary baseline data with respect to species is limited to the higher flora, namely angiosperms, and the higher fauna, namely vertebrates, including mammals, birds, reptiles, amphibians and fishes.

4.3.2.1 Primary Data

The primary data used towards the biodiversity baseline consists of the quantitative primary data presented in the EIA Report of the Project (dated September 2020) prepared by EQMS, supported by the qualitative primary observations recorded by the AECOM team in course of the site visit to the Study Area conducted during 2-5 November 2020.

4.3.2.2 Secondary Data

The secondary data used towards the biodiversity baseline was collated from suitably authenticated public domain sources, as also, informal consultations with local government officials and members of the local community.

Published sources relied upon include the output of a generic assessment using the Integrated Biodiversity Assessment Tool (IBAT) and the websites of international biodiversity conservation bodies, such as International Union for Conservation of Nature and Natural Resources (IUCN), BirdLife International, Ramsar Convention, Convention on Migratory Species (CMS) and Alliance for Zero Extinction (AZE).

Governmental officials interviewed include representatives of the local Forest Department, Fisheries Department, Agriculture Department and Irrigation Department. Local community members interviewed include representatives of the local farming and fishing communities.

4.3.3 Species Profile of the Study Area

This section presents the floristic and faunal species profiles reported from or recorded in the Study Area.

4.3.3.1 Floristic Species

This section describes the native floral profile of the Study Area based on the reported Forest Types of the Study Area.

Reported Forest Types

According to the Champion and Seth Classification of Indian Forests, the natural vegetation of the study area represents the following forest-types:

Type 4A/L1 [Type L1 (Littoral Forest) of Sub-group A (Littoral Forests) of Group 4 (Littoral & Swamp Forests)]

This forest type occurs in coastal areas of India and is associated with stabilized coastal dunes, as well as, the seaward edges of riverine deltas. The vegetation consists of scattered, small evergreen trees, interspersed with fewer deciduous trees.

Species typical of this forest type include:

Tree species, such as *Barringtonia spp.*, *Calophyllum inophyllum*, *Casuarina equisetifolia*, *Cordia myxa*, *Dalbergia sp.*, *Erythrina variegata*, *Hibiscus tiliaceus*, *Morinda citrifolia*, *Pongamia pinnata*, *Terminalia catappa*, *Thespesia populnea* and *Vitex negundo*;

Shrub species, such as *Caesalpinia bonduc*, *Clerodendrum inerme*, *Ixora spp* and *Tamarix sp.*; and

Herb species, such as *Clitoria ternatea*, *Crotalaria spp.*, *Desmodium umbellatum*, *Mucuna gigantea* and *Vigna retusa*.

Type 4B/TS1 [Type TS1 (Mangrove Scrub) of Sub-group B (Tidal Swamp Forests) of Group 4 (Littoral & Swamp Forests)]

This forest type also occurs in coastal areas of India and is associated with river deltas, edges of tidal creeks and sheltered muddy coasts. The vegetation consists of a few markedly gregarious species of relatively low height, all of which are evergreen, usually with entire coriaceous leaves.

Species typical of this forest type include:

Tree species, such as *Aegiceras sp.*, *Avicennia alba*, *Avicennia officinalis*, *Excoecaria agallocha* and *Sonneratia apetala*;

Shrub species, such as *Acanthus ilicifolius* and *Clerodendrum inerme*; and

Herb species, such as *Cynodon dactylon* and *Derris trifoliata*.

Source: H.G. Champion & S. K. Seth (2005). *A Revised Survey of the Forest Types of India*. Natraj Publishers, Dehradun.

4.3.3.2 Faunal Species

This section presents the faunal profile of the Study Area in terms of higher faunal species having reported ranges that include the Study Area, as well as, species recorded in the Study Area during the EIA survey by EQMS or the site visit by AECOM. The mammals, birds, reptiles, amphibians and fishes are listed in separate sub-sections.

Mammals

At least 65 species of mammals have reported ranges that include the Study Area. Of these, 5 species were recorded in the Study Area as part of the primary data collected by EQMS or AECOM. Significant species with respect to the IUCN Red List include 1 species designated as Critically Endangered, 2 as Endangered and 3 as Vulnerable. Significant species with respect to the WPA include 7 species listed in Schedule I.

Table 4-16 lists the mammal species of the Study Area. The table provides the scientific and common names of each species, the conservation status assigned to it by the International Union for Nature and Natural Resources (IUCN) and the Schedule of the Wildlife Protection Act, 1972 (WPA) under which it is listed. Names of species recorded in the Study Area by EQMS or AECOM appear in **bold** font.

DRAFT**Table 4-16: Mammals of the Study Area**

SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
1	<i>Anathana ellioti</i>	Madras Treeshrew	LC	-
2	<i>Axis axis</i>	Chital	LC	III
3	<i>Bandicota bengalensis</i>	Lesser Bandicoot Rat	LC	V
4	<i>Bandicota indica</i>	Greater Bandicoot Rat	LC	V
5	<i>Canis aureus</i>	Golden Jackal	LC	II
6	<i>Cuon alpinus</i>	Dhole	EN	II
7	<i>Cynopterus brachyotis</i>	Lesser Dog-faced Fruit Bat	LC	V
8	<i>Cynopterus sphinx</i>	Greater Short-nosed Fruit Bat	LC	V
9	<i>Felis chaus</i>	Jungle Cat	LC	II
10	<i>Funambulus palmarum</i>	Common Palm Squirrel	LC	-
11	<i>Golunda ellioti</i>	Indian Bush-rat	LC	V
12	<i>Herpestes edwardsii</i>	Indian Grey Mongoose	LC	II
13	<i>Herpestes smithii</i>	Ruddy Mongoose	LC	II
14	<i>Hipposideros ater</i>	Dusky Leaf-nosed Bat	LC	-
15	<i>Hipposideros fulvus</i>	Fulvous Leaf-nosed Bat	LC	-
16	<i>Hipposideros galeritus</i>	Cantor's Leaf-nosed Bat	LC	-
17	<i>Hipposideros speoris</i>	Schneider's Leaf-nosed Bat	LC	-
18	<i>Hystrix indica</i>	Indian Crested Porcupine	LC	IV
19	<i>Kerivoula picta</i>	Painted Woolly Bat	NT	-
20	<i>Lepus nigricollis</i>	Indian Hare	LC	IV
21	<i>Lutrogale perspicillata</i>	Smooth-coated Otter	VU	II
22	<i>Lyroderma lyra</i>	Greater False Vampire	LC	-
23	<i>Macaca radiata</i>	Bonnet Macaque	VU	II
24	<i>Madromys blanfordi</i>	White-tailed Wood Rat	LC	V
25	<i>Manis crassicaudata</i>	Indian Pangolin	EN	I
26	<i>Megaderma spasma</i>	Lesser False Vampire	LC	-
27	<i>Mellivora capensis</i>	Honey Badger	LC	I
28	<i>Millardia meltada</i>	Soft-furred Metad	LC	V
29	<i>Moschiola indica</i>	Indian Chevrotain	LC	I
30	<i>Muntiacus vaginalis</i>	Northern Red Muntjac	LC	III
31	<i>Mus booduga</i>	Common Indian Field Mouse	LC	V
32	<i>Mus musculus</i>	House Mouse	LC	V
33	<i>Mus platythrix</i>	Brown Spiny Mouse	LC	V
34	<i>Mus terricolor</i>	Earth-colored Mouse	LC	V
35	<i>Myotis horsfieldii</i>	Horsfield's Myotis	LC	-
36	<i>Paradoxurus hermaphroditus</i>	Common Palm Civet	LC	II
37	<i>Paraechinus nudiventris</i>	Madras Hedgehog	LC	-
38	<i>Petinomys fuscocapillus</i>	Travancore Flying Squirrel	LC	I

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SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
39	<i>Pipistrellus ceylonicus</i>	Kelaart's Pipistrelle	LC	-
40	<i>Pipistrellus coromandra</i>	Coromandel Pipistrelle	LC	-
41	<i>Prionailurus bengalensis</i>	Leopard Cat	LC	I
42	<i>Prionailurus rubiginosus</i>	Rusty-spotted Cat	NT	I
43	<i>Pteropus giganteus</i>	Indian Flying Fox	LC	V
44	<i>Rattus rattus</i>	House Rat	LC	V
45	<i>Ratufa indica</i>	Indian Giant Squirrel	LC	II
46	<i>Rhinolophus beddomei</i>	Beddome's Horseshoe Bat	LC	-
47	<i>Rhinolophus luctus</i>	Great Woolly Horsehoe Bat	LC	-
48	<i>Rhinolophus pusillus</i>	Least Horseshoe Bat	LC	-
49	<i>Rhinolophus rouxii</i>	Rufous Horseshoe Bat	LC	-
50	<i>Rhinopoma hardwickii</i>	Lesser Mouse-tailed Bat	LC	-
51	<i>Rousettus leschenaultii</i>	Leschenault's Rousette	LC	-
52	<i>Rusa unicolor</i>	Sambar	VU	III
53	<i>Saccolaimus saccolaimus</i>	Bare-rumped Sheathtail-bat	LC	-
54	<i>Scotophilus heathii</i>	Greater Asiatic Yellow House Bat	LC	-
55	<i>Scotophilus kuhlii</i>	Lesser Asiatic Yellow House Bat	LC	-
56	<i>Scotozous dormeri</i>	Dormer's Bat	LC	-
57	<i>Suncus murinus</i>	House Shrew	LC	-
58	<i>Sus scrofa</i>	Wild Boar	LC	III
59	<i>Tadarida aegyptiaca</i>	Egyptian Free-tailed Bat	LC	-
60	<i>Taphozous longimanus</i>	Long-winged Tomb Bat	LC	-
61	<i>Taphozous melanopogon</i>	Black-bearded Tomb Bat	LC	-
62	<i>Tatera indica</i>	Indian Gerbil	LC	V
63	<i>Vandeleuria oleracea</i>	Asiatic Long-tailed Climbing Mouse	LC	V
64	<i>Viverra civettina</i>	Malabar Civet	CR	I
65	<i>Viverricula indica</i>	Small Indian Civet	LC	II

*Status assigned by the International Union for Conservation of Nature and Natural Resources, where –CR – Critically Endangered; EN – Endangered; LC – Least Concern, NA – Not Assessed; NT – Near Threatened; and VU - Vulnerable.

**Schedules I to VI: Indian Wildlife (Protection) Act, 1972.

Sources: IUCN 2021. The IUCN Red List of Threatened Species. Version 2020-3; Schedules I to VI: Indian Wildlife (Protection) Act, 1972.

Birds

At least 327 species of birds, including 225 resident and 102 migratory species, have reported ranges that include the Study Area. Of these, 29 species, including 23 species of resident birds and 6 species of migratory birds, were recorded in the Study Area as part of the primary data collected by EQMS or AECOM. Significant species with respect to the IUCN Red List include 3 species designated as Critically Endangered, 3 as Endangered and 3 as Vulnerable.

Table 4-17 lists the resident bird species of the Study Area. The table provides the scientific and common names of each species, the conservation status assigned to it by the International Union for Nature and Natural Resources (IUCN) and the Schedule of the Wildlife Protection Act, 1972 (WPA)

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under which it is listed. Names of species recorded in the Study Area by EQMS or AECOM appear in **bold** font.

Table 4-17: Resident Birds of the Study Area

SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
1	<i>Accipiter badius</i>	Shikra	LC	I
2	<i>Accipiter trivirgatus</i>	Crested Goshawk	LC	I
3	<i>Accipiter virgatus</i>	Besra	LC	I
4	<i>Acridotheres fuscus</i>	Jungle Myna	LC	IV
5	<i>Acridotheres tristis</i>	Common Myna	LC	IV
6	<i>Acritillas indica</i>	Yellow-browed Bulbul	LC	IV
7	<i>Aegithina tiphia</i>	Common Iora	LC	IV
8	<i>Aerodramus unicolor</i>	Indian Swiftlet	LC	I
9	<i>Alauda gulgula</i>	Oriental Skylark	LC	IV
10	<i>Alcedo atthis</i>	Common Kingfisher	LC	IV
11	<i>Alcedo meninting</i>	Blue-eared Kingfisher	LC	IV
12	<i>Alcippe poioicephala</i>	Brown-cheeked Fulvetta	LC	-
13	<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	LC	IV
14	<i>Anas poecilorhyncha</i>	Indian Spot-billed Duck	LC	IV
15	<i>Anhinga melanogaster</i>	Darter	NT	IV
16	<i>Anthus rufulus</i>	Paddyfield Pipit	LC	IV
17	<i>Apus affinis</i>	Little Swift	LC	-
18	<i>Aquila fasciata</i>	Bonelli's Eagle	LC	I
19	<i>Arachnothera longirostra</i>	Little Spiderhunter	LC	-
20	<i>Ardea alba</i>	Great Egret	NT	IV
21	<i>Ardea intermedia</i>	Intermediate Egret	LC	IV
22	<i>Ardea purpurea</i>	Purple Heron	LC	IV
23	<i>Ardeola grayii</i>	Indian Pond Heron	LC	IV
24	<i>Argya subrufa</i>	Rufous Babbler	LC	IV
25	<i>Artamus fuscus</i>	Ashy Woodswallow	LC	-
26	<i>Athene brama</i>	Spotted Owlet	LC	IV
27	<i>Aviceda jerdoni</i>	Jerdon's Baza	LC	IV
28	<i>Aviceda leuphotes</i>	Black Baza	LC	IV
29	<i>Botaurus stellaris</i>	Great Bittern	LC	IV
30	<i>Bubo bengalensis</i>	Indian Eagle Owl	LC	IV
31	<i>Bubulcus ibis</i>	Cattle Egret	LC	IV
32	<i>Buceros bicornis</i>	Great Hornbill	VU	I
33	<i>Burhinus indicus</i>	Indian Thick-knee	LC	IV
34	<i>Butastur teesa</i>	White-eyed Buzzard	LC	I
35	<i>Buteo buteo</i>	Common Buzzard	LC	I
36	<i>Butorides striata</i>	Striated Heron	LC	IV

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SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
37	<i>Cacomantis sonneratii</i>	Banded Bay Cuckoo	LC	IV
38	<i>Caprimulgus affinis</i>	Savanna Nightjar	LC	IV
39	<i>Caprimulgus asiaticus</i>	Indian Nightjar	LC	IV
40	<i>Caprimulgus atripennis</i>	Jerdon's Nightjar	LC	IV
41	<i>Caprimulgus indicus</i>	Jungle Nightjar	LC	IV
42	<i>Cecropis daurica</i>	Red-rumped Swallow	LC	-
43	<i>Centropus bengalensis</i>	Lesser Coucal	LC	-
44	<i>Centropus sinensis</i>	Southern Coucal	LC	-
45	<i>Ceryle rudis</i>	Pied Kingfisher	LC	IV
46	<i>Ceyx erithaca</i>	Oriental Dwarf Kingfisher	LC	IV
47	<i>Chalcophaps indica</i>	Emerald Dove	LC	IV
48	<i>Charadrius dubius</i>	Little Ringed Plover	LC	IV
49	<i>Chloropsis aurifrons</i>	Golden-fronted Leafbird	LC	IV
50	<i>Chloropsis jerdoni</i>	Jerdon's Leafbird	LC	IV
51	<i>Chrysocolaptes festivus</i>	White-naped Woodpecker	LC	IV
52	<i>Chrysocolaptes guttacristatus</i>	Greater Goldenback	LC	IV
53	<i>Chrysomma sinense</i>	Yellow-eyed Babbler	LC	IV
54	<i>Ciconia ciconia</i>	White Stork	LC	I
55	<i>Ciconia episcopus</i>	Woolly-necked Stork	VU	IV
56	<i>Cinnyris asiaticus</i>	Purple Sunbird	LC	IV
57	<i>Circaetus gallicus</i>	Short-toed Snake Eagle	LC	I
58	<i>Cisticola exilis</i>	Zitting Cisticola	LC	-
59	<i>Clamator jacobinus</i>	Jacobin Cuckoo	LC	IV
60	<i>Columba livia</i>	Rock Pigeon	LC	IV
61	<i>Copsychus saularis</i>	Oriental Magpie Robin	LC	-
62	<i>Coracias benghalensis</i>	Indian Roller	LC	IV
63	<i>Coracina macei</i>	Large Cuckooshrike	LC	-
64	<i>Corvus macrorhynchos</i>	Jungle Crow	LC	V
65	<i>Corvus splendens</i>	House Crow	LC	V
66	<i>Cuculus micropterus</i>	Indian Cuckoo	LC	IV
67	<i>Culicicapa ceylonensis</i>	Grey-headed Canary Flycatcher	LC	-
68	<i>Cursorius coromandelicus</i>	Indian Courser	LC	-
69	<i>Cyornis tickelliae</i>	Tickell's Blue Flycatcher	LC	-
70	<i>Cypsiurus balasiensis</i>	Asian Palm Swift	LC	-
71	<i>Dendrocitta leucogastra</i>	White-bellied Treepie	LC	IV
72	<i>Dendrocitta vagabunda</i>	Rufous Treepie	LC	IV
73	<i>Dendrocygna bicolor</i>	Fulvous Whistling-duck	LC	IV
74	<i>Dendrocygna javanica</i>	Lesser Whistling-duck	LC	IV
75	<i>Dicaeum agile</i>	Thick-billed Flowerpecker	LC	IV

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SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
76	<i>Dicaeum concolor</i>	Nilgiri Flowerpecker	LC	IV
77	<i>Dicaeum erythrorhynchos</i>	Pale-billed Flowerpecker	LC	IV
78	<i>Dicrurus aeneus</i>	Bronzed Drongo	LC	IV
79	<i>Dicrurus caerulescens</i>	White-bellied Drongo	LC	IV
80	<i>Dicrurus hottentottus</i>	Spangled Drongo	LC	IV
81	<i>Dicrurus macrocercus</i>	Black Drongo	LC	IV
82	<i>Dicrurus paradiseus</i>	Greater Racket-tailed Drongo	LC	IV
83	<i>Dinopium benghalense</i>	Lesser Goldenback	LC	IV
84	<i>Dinopium javanense</i>	Common Goldenback	LC	IV
85	<i>Dryocopus javensis</i>	White-bellied Woodpecker	LC	IV
86	<i>Ducula aenea</i>	Green Imperial Pigeon	LC	IV
87	<i>Dumetia hyperythra</i>	Tawny-bellied Babbler	LC	IV
88	<i>Elanus caeruleus</i>	Black-winged Kite	LC	I
89	<i>Eremopterix griseus</i>	Ashy-crowned Sparrow Lark	LC	IV
90	<i>Eudynamys scolopaceus</i>	Asian Koel	LC	IV
91	<i>Falco peregrinus</i>	Peregrine Falcon	LC	I
92	<i>Falco severus</i>	Oriental Hobby	LC	IV
93	<i>Fulica atra</i>	Eurasian Coot	LC	IV
94	<i>Galerida malabarica</i>	Malabar Lark	LC	IV
95	<i>Gallicrex cinerea</i>	Watercock	LC	IV
96	<i>Gallinula chloropus</i>	Common Moorhen	LC	IV
97	<i>Galloperdix spadicea</i>	Red Spurfowl	LC	IV
98	<i>Gallus sonneratii</i>	Grey Junglefowl	LC	IV
99	<i>Geokichla citrina</i>	Orange-headed Thrush	LC	IV
100	<i>Glareola lactea</i>	Small Pratincole	LC	-
101	<i>Glaucomys radiatum</i>	Jungle Owlet	LC	IV
102	<i>Gracula indica</i>	Lesser Hill Myna	LC	I
103	<i>Gymnoris xanthocollis</i>	Chestnut-shouldered Petronia	LC	-
104	<i>Gyps bengalensis</i>	White-rumped Vulture	CR	I
105	<i>Gyps indicus</i>	Indian Vulture	CR	I
106	<i>Halcyon pileata</i>	Black-capped Kingfisher	LC	IV
107	<i>Halcyon smyrnensis</i>	White-breasted Kingfisher	LC	IV
108	<i>Haliaeetus leucogaster</i>	White-bellied Sea Eagle	LC	I
109	<i>Haliastur indus</i>	Brahminy Kite	LC	I
110	<i>Harpactes fasciatus</i>	Malabar Trogan	LC	IV
111	<i>Hemicircus canente</i>	Heart-spotted Woodpecker	LC	IV
112	<i>Hemiprocne coronata</i>	Crested Treeswift	LC	-
113	<i>Hemipus picatus</i>	Bar-winged Flycatcher-shrike	LC	-
114	<i>Hierococcyx varius</i>	Common Hawk Cuckoo	LC	IV

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SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
115	<i>Hirundapus giganteus</i>	Brown-backed Needletail	LC	-
116	<i>Hydrophasianus chirurgus</i>	Pheasant-tailed Jacana	LC	IV
117	<i>Hypothymis azurea</i>	Black-naped Monarch	LC	-
118	<i>Hypsipetes ganeesa</i>	Square-tailed Bulbul	LC	IV
119	<i>Icthyophaga ichthyaetus</i>	Grey-headed Fish Eagle	NT	I
120	<i>Ictinaetus malaiensis</i>	Black Eagle	LC	I
121	<i>Irena puella</i>	Asian Fairy Bluebird	LC	IV
122	<i>Ixobrychus cinnamomeus</i>	Cinnamon Bittern	LC	IV
123	<i>Ixobrychus sinensis</i>	Yellow Bittern	LC	IV
124	<i>Ketupa zeylonensis</i>	Brown Fish Owl	LC	IV
125	<i>Kittacincla malabarica</i>	White-rumped Shama	LC	-
126	<i>Lalage melanoptera</i>	Black-headed Cuckoo-shrike	LC	-
127	<i>Leiopicus mahrattensis</i>	Yellow-crowned Woodpecker	LC	IV
128	<i>Leptocoma zeylonica</i>	Purple-rumped Sunbird	LC	IV
129	<i>Lewinia striata</i>	Slaty-breasted Rail	LC	IV
130	<i>Lonchura malacca</i>	Black-headed Munia	LC	IV
131	<i>Lonchura punctulata</i>	Scaly-breasted Munia	LC	IV
132	<i>Lonchura striata</i>	White-rumped Munia	LC	IV
133	<i>Lophotriorchis kienerii</i>	Rufous-bellied Eagle	NT	I
134	<i>Loriculus vernalis</i>	Vernal Hanging Parrot	LC	IV
135	<i>Merops leschenaulti</i>	Chestnut-headed Bee-eater	LC	-
136	<i>Merops orientalis</i>	Green Bee-eater	LC	-
137	<i>Metopidius indicus</i>	Bronze-winged Jacana	LC	IV
138	<i>Microcarbo niger</i>	Little Cormorant	LC	IV
139	<i>Micropternus brachyurus</i>	Rufous Woodpecker	LC	IV
140	<i>Milvus migrans</i>	Black Kite	LC	I
141	<i>Mirafra affinis</i>	Jerdon's Bushlark	LC	IV
142	<i>Motacilla maderaspatensis</i>	White-browed Wagtail	LC	-
143	<i>Myophonus horsfieldii</i>	Malabar Whistling Thrush	LC	IV
144	<i>Neophron percnopterus</i>	Egyptian Vulture	NT	IV
145	<i>Nettapus coromandelianus</i>	Cotton Pygmy-goose	LC	IV
146	<i>Ninox scutulata</i>	Brown Hawk Owl	LC	IV
147	<i>Nisaetus cirrhatus</i>	Crested Hawk Eagle	LC	I
148	<i>Nycticorax nycticorax</i>	Black-crowned Night Heron	LC	IV
149	<i>Nyctyornis athertoni</i>	Blue-bearded Bee-eater	LC	-
150	<i>Ocypterus griseus</i>	Malabar Grey Hornbill	LC	-
151	<i>Oriolus xanthornus</i>	Black-hooded Oriole	LC	IV
152	<i>Orthotomus sutorius</i>	Common Tailorbird	LC	-
153	<i>Otus bakkamoena</i>	Indian Scops Owl	LC	IV

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SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
154	<i>Otus sunia</i>	Oriental Scops Owl	LC	IV
155	<i>Parus major</i>	Great Tit	LC	IV
156	<i>Passer domesticus</i>	House Sparrow	LC	-
157	<i>Pavo cristatus</i>	Indian Peafowl	LC	I
158	<i>Pelargopsis capensis</i>	Stork-billed Kingfisher	LC	IV
159	<i>Pelecanus philippensis</i>	Spot-billed Pelican	NT	IV
160	<i>Pellorneum ruficeps</i>	Puff-throated Babbler	LC	IV
161	<i>Perdicula asiatica</i>	Jungle Bush Quail	LC	IV
162	<i>Pericrocotus cinnamomeus</i>	Small Minivet	LC	IV
163	<i>Pericrocotus flammeus</i>	Scarlet Minivet	LC	IV
164	<i>Pernis ptilorhynchus</i>	Oriental Honey-buzzard	LC	I
165	<i>Phaenicophaeus viridirostris</i>	Blue-faced Malkoha	LC	-
166	<i>Phalacrocorax fuscicollis</i>	Indian Cormorant	LC	IV
167	<i>Picoides nanus</i>	Indian Pygmy Woodpecker	LC	IV
168	<i>Picumnus innominatus</i>	Speckled Piculet	LC	-
169	<i>Picus chlorolophus</i>	Lesser Yellownape	LC	IV
170	<i>Picus xanthopygaeus</i>	Streak-throated Woodpecker	LC	IV
171	<i>Platalea leucorodia</i>	Eurasian Spoonbill	LC	I
172	<i>Ploceus manyar</i>	Streaked Weaver	LC	IV
173	<i>Ploceus philippinus</i>	Baya Weaver	LC	IV
174	<i>Pomatorhinus horsfieldii</i>	Indian Scimitar Babbler	LC	IV
175	<i>Porphyrio porphyrio</i>	Purple Swamphen	LC	IV
176	<i>Prinia hodgsonii</i>	Grey-breasted Prinia	LC	-
177	<i>Prinia inornata</i>	Plain Prinia	LC	-
178	<i>Prinia socialis</i>	Ashy Prinia	LC	-
179	<i>Pseudibis papillosa</i>	Red-naped Ibis	LC	IV
180	<i>Psilopogon haemacephalus</i>	Coppersmith Barbet	LC	IV
181	<i>Psilopogon malabaricus</i>	Malabar Barbet	LC	IV
182	<i>Psilopogon viridis</i>	White-cheeked Barbet	LC	IV
183	<i>Psilopogon zeylanicus</i>	Brown-headed Barbet	LC	IV
184	<i>Psittacula columboides</i>	Malabar Parakeet	LC	IV
185	<i>Psittacula cyanocephala</i>	Plum-headed Parakeet	LC	IV
186	<i>Psittacula krameri</i>	Rose-ringed Parakeet	LC	IV
187	<i>Ptyonoprogne concolor</i>	Dusky Crag Martin	LC	-
188	<i>Pycnonotus cafer</i>	Red-vented Bulbul	LC	IV
189	<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul	LC	IV
190	<i>Pycnonotus luteolus</i>	White-browed Bulbul	LC	IV
191	<i>Pycnonotus xantholaemus</i>	Yellow-throated Bulbul	VU	IV
192	<i>Rhipidura aureola</i>	White-browed Fantail	LC	-

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SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
193	<i>Rhopocichla atriceps</i>	Dark-fronted Babbler	LC	IV
194	<i>Rostratula benghalensis</i>	Greater Painted-snipe	LC	IV
195	<i>Rubigula gularis</i>	Flame-throated Bulbul	LC	IV
196	<i>Sarcogyps calvus</i>	Red-headed Vulture	CR	IV
197	<i>Saxicola caprata</i>	Pied Bushchat	LC	-
198	<i>Saxicoloides fulicatus</i>	Indian Robin	LC	-
199	<i>Sitta frontalis</i>	Velvet-fronted Nuthatch	LC	-
200	<i>Spilopelia senegalensis</i>	Laughing Dove	LC	IV
201	<i>Spilopelia suratensis</i>	Spotted Dove	LC	IV
202	<i>Spilornis cheela</i>	Crested Serpent Eagle	LC	I
203	<i>Sterna aurantia</i>	River Tern	NT	-
204	<i>Streptopelia decaocto</i>	Eurasian Collared Dove	LC	IV
205	<i>Strix leptogrammica</i>	Brown Wood Owl	LC	IV
206	<i>Strix ocellata</i>	Mottled Wood Owl	LC	IV
207	<i>Sturnia pagodarum</i>	Brahminy Starling	LC	IV
208	<i>Syphoetides indicus</i>	Lesser Florican	EN	I
209	<i>Taccocua leschenaultii</i>	Sirkeer Malkoha	LC	-
210	<i>Tachybaptus ruficollis</i>	Little Grebe	LC	IV
211	<i>Tachymarptis melba</i>	Alpine Swift	LC	-
212	<i>Tephrodornis pondicerianus</i>	Common Woodshrike	LC	-
213	<i>Tephrodornis sylvicola</i>	Malabar Woodshrike	LC	-
214	<i>Terpsiphone paradisi</i>	Asian Paradise Flycatcher	LC	-
215	<i>Threskiornis melanocephalus</i>	Black-headed Ibis	NT	IV
216	<i>Treron affinis</i>	Grey-fronted Green Pigeon	LC	IV
217	<i>Turdoides affinis</i>	Yellow-billed Babbler	LC	IV
218	<i>Turdoides striata</i>	Jungle Babbler	LC	IV
219	<i>Turnix suscitator</i>	Barred Buttonquail	LC	IV
220	<i>Tyto alba</i>	Barn Owl	LC	IV
221	<i>Upupa epops</i>	Common Hoopoe	LC	-
222	<i>Vanellus indicus</i>	Red-wattled Lapwing	LC	-
223	<i>Vanellus malabaricus</i>	Yellow-wattled Lapwing	LC	-
224	<i>Zapornia fusca</i>	Ruddy-breasted Crake	LC	IV
225	<i>Zosterops palpebrosus</i>	Oriental White-eye	EN	IV

*Status assigned by the International Union for Conservation of Nature and Natural Resources, where –CR – Critically Endangered; EN – Endangered; LC – Least Concern, NA – Not Assessed; NT – Near Threatened; and VU - Vulnerable.

**Schedules I to VI: Indian Wildlife (Protection) Act, 1972.

Sources: R. Grimmett, C. Inskip & T. Inskip (2011). Birds of the Indian Subcontinent. Oxford University Press, pp 1-528
IUCN 2021. The IUCN Red List of Threatened Species. Version 2020-3; Schedules I to VI: Indian Wildlife (Protection) Act, 1972.

Table 4-18 lists the migratory bird species of the Study Area. The table provides the scientific and common names of each species, the conservation status assigned to it by the International Union for

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Nature and Natural Resources (IUCN), the Schedule of the Wildlife Protection Act, 1972 (WPA) under which it is listed, as well as, its migratory status in terms of being a winter (W), summer (S) or passage (P) migrant with respect to the Study Area. Names of species recorded in the Study Area by EQMS or AECOM appear in **bold** font.

Table 4-18: Migratory Birds of the Study Area

SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**	Migratory Status***
1	<i>Accipiter nisus</i>	Eurasian Sparrowhawk	LC	I	W
2	<i>Acrocephalus agricola</i>	Paddyfield Warbler	LC	-	W
3	<i>Acrocephalus dumetorum</i>	Blyth's Reed Warbler	LC	-	W
4	<i>Actitis hypoleucos</i>	Common Sandpiper	LC	IV	W
5	<i>Anas acuta</i>	Northern Pintail	LC	IV	W
6	<i>Anas crecca</i>	Common Teal	LC	IV	W
7	<i>Anas querquedula</i>	Garganey	LC	IV	W
8	<i>Anastomus oscitans</i>	Asian Openbill	LC	IV	W
9	<i>Anthus godlewskii</i>	Blyth's Pipit	LC	IV	W
10	<i>Apus pacificus</i>	Fork-tailed Swift	LC	-	W
11	<i>Aquila nipalensis</i>	Steppe Eagle	LC	I	W
12	<i>Ardea cinerea</i>	Grey Heron	LC	IV	W
13	<i>Arenaria interpres</i>	Ruddy Turnstone	LC	-	W
14	<i>Arundinicax aedon</i>	Thick-billed Warbler	LC	-	W
15	<i>Cacomantis passerinus</i>	Grey-bellied Cuckoo	LC	IV	W
16	<i>Calidris alba</i>	Sanderling	LC	-	W
17	<i>Calidris ferruginea</i>	Curlew Sandpiper	NT	IV	W
18	<i>Calidris minuta</i>	Little Stint	LC	-	W
19	<i>Calidris temminckii</i>	Temminck's Stint	LC	-	W
20	<i>Charadrius alexandrinus</i>	Kentish Plover	LC	IV	W
21	<i>Charadrius leschenaultii</i>	Greater Sand Plover	LC	IV	W
22	<i>Charadrius mongolus</i>	Lesser Sand Plover	LC	IV	W
23	<i>Chlidonias hybrida</i>	Whiskered Tern	LC	-	W
24	<i>Ciconia nigra</i>	Black Stork	LC	IV	W
25	<i>Circus aeruginosus</i>	Eurasian Marsh Harrier	LC	I	W
26	<i>Circus macrourus</i>	Pallid Harrier	NT	I	W
27	<i>Circus melanoleucus</i>	Pied Harrier	LC	I	W
28	<i>Circus pygargus</i>	Montagu's Harrier	LC	I	W
29	<i>Clamator coromandus</i>	Chestnut-winged Cuckoo	LC	IV	W
30	<i>Coturnix coromandelica</i>	Rain Quail	LC	IV	W
31	<i>Cuculus poliocephalus</i>	Lesser Cuckoo	LC	IV	P
32	<i>Cyornis rubeculoides</i>	Blue-throated Blue Flycatcher	LC	-	W

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SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**	Migratory Status***
33	<i>Dicrurus leucophaeus</i>	Ashy Drongo	LC	IV	W
34	<i>Egretta garzetta</i>	Little Egret	LC	IV	W
35	<i>Egretta gularis</i>	Western Reef Egret	LC	IV	W
36	<i>Eumyias thalassinus</i>	Verditer Flycatcher	LC	-	W
37	<i>Falco amurensis</i>	Amur Falcon	LC	IV	P
38	<i>Falco naumanni</i>	Lesser Kestrel	LC	IV	P
39	<i>Falco tinnunculus</i>	Common Kestrel	LC	IV	W
40	<i>Ficedula ruficauda</i>	Rusty-tailed Flycatcher	LC	-	W
41	<i>Gallinago gallinago</i>	Common Snipe	LC	IV	W
42	<i>Gallinago megala</i>	Swinhoe's Snipe	LC	IV	W
43	<i>Gallinago stenura</i>	Pin-tailed Snipe	LC	IV	W
44	<i>Gelochelidon nilotica</i>	Gull-billed Tern	LC	-	W
45	<i>Haematopus ostralegus</i>	Eurasian Oystercatcher	LC	IV	W
46	<i>Hieraetus pennatus</i>	Booted Eagle	LC	I	W
47	<i>Hierococcyx sparverioides</i>	Large Hawk Cuckoo	LC	IV	W
48	<i>Himantopus himantopus</i>	Black-winged Stilt	LC	IV	W
49	<i>Hirundo rustica</i>	Barn Swallow	LC	-	W
50	<i>Hydroprogne caspia</i>	Caspian Tern	LC	-	W
51	<i>Ixobrychus flavicollis</i>	Black Bittern	LC	IV	W
52	<i>Lanius cristatus</i>	Brown Shrike	LC	-	W
53	<i>Lanius schach</i>	Long-tailed Shrike	LC	-	W
54	<i>Lanius vittatus</i>	Bay-backed Shrike	LC	-	W
55	<i>Larus brunnicephalus</i>	Brown-headed Gull	LC	IV	W
56	<i>Larus fuscus</i>	Lesser Black-backed Gull	LC	-	W
57	<i>Larus ichthyaetus</i>	Pallas's Gull	LC	-	W
58	<i>Larus ridibundus</i>	Black-headed Gull	LC	-	W
59	<i>Larvivora brunnea</i>	Indian Blue Robin	LC	-	W
60	<i>Limosa lapponica</i>	Bar-tailed Godwit	NT	-	W
61	<i>Locustella naevia</i>	Grasshopper Warbler	LC	-	W
62	<i>Lymnocryptes minimus</i>	Jack Snipe	LC	IV	W
63	<i>Merops philippinus</i>	Blue-tailed Bee-eater	LC	-	W
64	<i>Monticola cinclorhyncha</i>	Blue-capped Rock Thrush	LC	-	W
65	<i>Monticola solitarius</i>	Blue Rock Thrush	LC	-	W
66	<i>Motacilla alba</i>	White Wagtail	LC	-	W
67	<i>Motacilla cinerea</i>	Grey Wagtail	LC	-	W
68	<i>Motacilla flava</i>	Yellow Wagtail	LC	-	W
69	<i>Muscicapa dauurica</i>	Asian Brown Flycatcher	LC	-	W

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SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**	Migratory Status***
70	<i>Mycteria leucocephala</i>	Painted Stork	NT	IV	W
71	<i>Numenius arquata</i>	Eurasian Curlew	NT	IV	W
72	<i>Numenius phaeopus</i>	Whimbrel	LC	-	W
73	<i>Oriolus chinensis</i>	Black-naped Oriole	LC	IV	W
74	<i>Oriolus kundoo</i>	Indian Golden Oriole	LC	IV	W
75	<i>Pandion haliaetus</i>	Osprey	LC	I	W
76	<i>Pastor roseus</i>	Rosy Starling	LC	IV	W
77	<i>Phalacrocorax carbo</i>	Great Cormorant	LC	IV	P
78	<i>Phylloscopus affinis</i>	Tickell's Leaf Warbler	LC	-	W
79	<i>Phylloscopus magnirostris</i>	Large-billed Leaf Warbler	LC	-	W
80	<i>Phylloscopus nitidus</i>	Green Warbler	NT	-	W
81	<i>Phylloscopus trochiloides</i>	Greenish Warbler	LC	-	W
82	<i>Phylloscopus tytleri</i>	Tytler's Leaf Warbler	LC	-	W
83	<i>Pitta brachyura</i>	Indian Pitta	LC	IV	W
84	<i>Plegadis falcinellus</i>	Glossy Ibis	LC	IV	W
85	<i>Pluvialis fulva</i>	Pacific Golden Plover	LC	IV	W
86	<i>Pluvialis squatarola</i>	Grey Plover	LC	IV	W
87	<i>Rallina eurizonoides</i>	Slaty-legged Crake	LC	IV	S
88	<i>Scolopax rusticola</i>	Eurasian Woodcock	LC	-	W
89	<i>Sterna acuticauda</i>	Black-bellied Tern	EN	-	W
90	<i>Sterna hirundo</i>	Common Tern	LC	-	W
91	<i>Sternula albifrons</i>	Little Tern	LC	-	W
92	<i>Sturnia malabarica</i>	Chestnut-tailed Starling	LC	IV	W
93	<i>Thalasseus bengalensis</i>	Lesser Crested Tern	LC	-	W
94	<i>Treron phoenicopterus</i>	Yellow-footed Green Pigeon	LC	IV	W
95	<i>Tringa glareola</i>	Wood Sandpiper	LC	IV	W
96	<i>Tringa nebularia</i>	Common Greenshank	LC	IV	W
97	<i>Tringa ochropus</i>	Green Sandpiper	LC	IV	W
98	<i>Tringa stagnatilis</i>	Marsh Sandpiper	LC	IV	W
99	<i>Tringa totanus</i>	Common Redshank	LC	IV	W
100	<i>Turnix tanki</i>	Yellow-legged Buttonquail	LC	IV	W
101	<i>Xenus cinereus</i>	Terek Sandpiper	LC	IV	W
102	<i>Zapornia pusilla</i>	Baillon's Crake	LC	IV	W

*Status assigned by the International Union for Conservation of Nature and Natural Resources, where –CR – Critically Endangered; EN – Endangered; LC – Least Concern, NA – Not Assessed; NT – Near Threatened; and VU - Vulnerable.

**Schedules I to VI: Indian Wildlife (Protection) Act, 1972.

***Migratory status of species, where W – Winter, S – Summer and P – Passage.

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SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**	Migratory Status***
<i>Sources: R. Grimmett, C. Inskip & T. Inskip (2011). Birds of the Indian Subcontinent. Oxford University Press, pp 1-528</i>					
<i>IUCN 2021. The IUCN Red List of Threatened Species. Version 2020-3; Schedules I to VI: Indian Wildlife (Protection) Act, 1972.</i>					
Reptiles					
At least 33 reptile species have reported ranges that include the Study Area. Of these, 3 species were recorded in the Study Area as part of the primary data collected by EQMS or AECOM. Significant species with respect to the IUCN Red List include 2 species designated as Vulnerable. Significant species with respect to the WPA include 4 species listed in Schedule I.					
Table 4-19 lists the reptile species of the Study Area. The table provides the scientific and common names of each species, the conservation status assigned to it by the International Union for Nature and Natural Resources (IUCN) and the Schedule of the Wildlife Protection Act, 1972 (WPA) under which it is listed. Names of species recorded in the Study Area by EQMS or AECOM appear in bold font.					
Table 4-19: Reptiles of the Study Area					
SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**	
1	<i>Ahaetulla pulverulenta</i>	Brown Vine Snake	LC	IV	
2	<i>Boiga beddomei</i>	Beddome's Cat Snake	DD	IV	
3	<i>Boiga forsteni</i>	Forsten's Cat Snake	LC	IV	
4	<i>Calliophis nigrescens</i>	Striped Coral Snake	LC	IV	
5	<i>Caretta caretta</i>	Loggerhead Turtle	VU	I	
6	<i>Chamaeleo zeylanicus</i>	Asian Chameleon	LC	II	
7	<i>Crocodylus palustris</i>	Mugger	VU	I	
8	<i>Crocodylus porosus</i>	Saltwater Crocodile	LC	I	
9	<i>Dendrelaphis ashoki</i>	Ashok's Bronzeback	LC	IV	
10	<i>Dendrelaphis bifrenalis</i>	Boulenger's Bronzeback	LC	IV	
11	<i>Draco dussumieri</i>	Southern Flying Lizard	LC	-	
12	<i>Eutropis carinata</i>	Keeled Indian Mabuya	LC	-	
13	<i>Grypotyphlops acutus</i>	Beaked Worm Snake	LC	IV	
14	<i>Hebius beddomei</i>	Nilgiri Keelback	LC	IV	
15	<i>Hemidactylus brookii</i>	Brooke's House Gecko	LC	-	
16	<i>Hemidactylus frenatus</i>	Common House Gecko	LC	-	
17	<i>Hemidactylus maculatus</i>	Spotted Leaf-toed Gecko	LC	-	
18	<i>Hemidactylus reticulatus</i>	Reticulate Leaf-toed Gecko	LC	-	
19	<i>Kaestlea travancorica</i>	Barbour's Ground Skink	LC	-	
20	<i>Lycodon travancoricus</i>	Travancore Wolf Snake	LC	IV	
21	<i>Lygosoma guentheri</i>	Günther's Writhing Snake	LC	IV	
22	<i>Melanochelys trijuga</i>	Indian Black Turtle	LC	-	
23	<i>Monilesaurus rouxii</i>	Roux's Forest Calotes	LC	-	
24	<i>Oligodon affinis</i>	Western Kukri Snake	LC	IV	
25	<i>Oligodon taeniolatus</i>	Streaked Kukri Snake	LC	IV	

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SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
26	<i>Oligodon travancoricus</i>	Travancore Kukri Snake	DD	IV
27	<i>Psammophilus blanfordianus</i>	Blanford's Rock Agama	LC	-
28	<i>Pseudocerastes persicus</i>	Persian Horned Viper	LC	IV
29	<i>Sitana ponticeriana</i>	Fan Throated Lizard	LC	-
30	<i>Sphenomorphus dussumieri</i>	Dussumier's Forest Skink	LC	-
31	<i>Trimeresurus gramineus</i>	Common Bamboo Viper	LC	IV
32	<i>Trimeresurus malabaricus</i>	Malabar Pit Viper	LC	IV
33	<i>Varanus bengalensis</i>	Bengal Monitor Lizard	LC	I

*Status assigned by the International Union for Conservation of Nature and Natural Resources, where –CR – Critically Endangered; EN – Endangered; LC – Least Concern, NA – Not Assessed; NT – Near Threatened; and VU - Vulnerable.

**Schedules I to VI: Indian Wildlife (Protection) Act, 1972.

Sources: IUCN 2021. The IUCN Red List of Threatened Species. Version 2020-3; Schedules I to VI: Indian Wildlife (Protection) Act, 1972.

Amphibians

At least 17 amphibian species have reported ranges that include the Study Area. Of these, 2 species were recorded in the Study Area as part of the primary data collected by EQMS or AECOM. None of these species is designated by the IUCN as threatened or near-threatened or is listed in Schedule I of the WPA.

Table 4-20 lists the amphibian species of the Study Area. The table provides the scientific and common names of each species, the conservation status assigned to it by the International Union for Nature and Natural Resources (IUCN) and the Schedule of the Wildlife Protection Act, 1972 (WPA) under which it is listed. Names of species recorded in the Study Area by EQMS or AECOM appear in **bold** font.

Table 4-20: Amphibians of the Study Area

SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
1	<i>Duttaphrynus melanostictus</i>	Asian Common Toad	LC	-
2	<i>Duttaphrynus stomaticus</i>	Indian Marbled Toad	LC	-
3	<i>Euphlyctis cyanophlyctis</i>	Indian Skittering Frog	LC	-
4	<i>Euphlyctis hexadactylus</i>	Indian Green Frog	LC	IV
5	<i>Fejervarya limnocharis</i>	Asian Grass Frog	LC	-
6	<i>Fejervarya rufescens</i>	Malabar Wart Frog	LC	-
7	<i>Hoplobatrachus crassus</i>	Jerdon's Bullfrog	LC	IV
8	<i>Hoplobatrachus tigerinus</i>	Indian Bullfrog	LC	IV
9	<i>Hydrophylax malabaricus</i>	Malabar Fungoid Frog	LC	-
10	<i>Ichthyophis tricolor</i>	Maddatorai Caecilian	LC	-
11	<i>Microhyla ornata</i>	Ant Frog	LC	-
12	<i>Microhyla rubra</i>	Guangdong Rice Frog	LC	-
13	<i>Polypedates maculatus</i>	Indian Tree Frog	LC	-
14	<i>Sphaerotheca breviceps</i>	Indian Burrowing Frog	LC	-
15	<i>Uperodon globulosus</i>	Indian Globular Frog	LC	-
16	<i>Uperodon systema</i>	Balloon Frog	LC	-

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SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
17	<i>Uperodon variegatus</i>	Eluru Dot Frog	LC	-

*Status assigned by the International Union for Conservation of Nature and Natural Resources, where –CR – Critically Endangered; EN – Endangered; LC – Least Concern, NA – Not Assessed; NT – Near Threatened; and VU - Vulnerable.

**Schedules I to VI: Indian Wildlife (Protection) Act, 1972.

Sources: IUCN 2021. The IUCN Red List of Threatened Species. Version 2020-3; Schedules I to VI: Indian Wildlife (Protection) Act, 1972.

Fishes

At least 147 fish species have reported ranges that include the Study Area. None of these species were recorded in the Study Area as part of the primary data collected by EQMS or AECOM.

Significant species with respect to the IUCN Red List include 1 species designated as Critically Endangered, 6 as Endangered and 10 as Vulnerable. None of the species are listed in the Schedule I of the WPA.

Table 4-21 lists the fish species of the Study Area. The table provides the scientific and common names of each species, the conservation status assigned to it by the International Union for Nature and Natural Resources (IUCN) and the Schedule of the Wildlife Protection Act, 1972 (WPA) under which it is listed. Names of species recorded in the Study Area by EQMS or AECOM appear in **bold** font.

Table 4-21: Fishes of the Study Area

SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
1	<i>Ambassis urotaenia</i>	Bleeker's Glass Perchlet	LC	-
2	<i>Amblypharyngodon microlepis</i>	Indian Carplet	LC	-
3	<i>Anabas testudineus</i>	Climbing Perch	LC	-
4	<i>Anguilla bengalensis</i>	Indian Mottled Eel	NT	-
5	<i>Anguilla bicolor</i>	Shortfin Eel	NT	-
6	<i>Anguilla marmorata</i>	Marbled Eel	LC	-
7	<i>Aplocheilus blockii</i>	Green Panchax	LC	-
8	<i>Aplocheilus lineatus</i>	Striped panchax	LC	-
9	<i>Aplocheilus panchax</i>	Blue Panchax	LC	-
10	<i>Aplocheilus parvus</i>	Dwarf panchax	LC	-
11	<i>Apogon hyalosoma</i>	Mangrove Cardinalfish	LC	-
12	<i>Arius arius</i>	Threadfin Sea Catfish	LC	-
13	<i>Aurigequula fasciata</i>	Threadfin Ponyfish	LC	-
14	<i>Awaous grammepomus</i>	-	LC	-
15	<i>Bagarius yarrelli</i>	-	VU	-
16	<i>Balistes rotundatus</i>	-	LC	-
17	<i>Barbodes carnaticus</i>	Carnatic Carp	LC	-
18	<i>Barilius bakeri</i>	Malabar Baril	LC	-
19	<i>Batasio travancoria</i>	Travancore Batasio	VU	-
20	<i>Bostrychus sinensis</i>	Four-eyed Sleeper	LC	-
21	<i>Bunaka gyrinoides</i>	Green-backed Gudgeon	LC	-
22	<i>Callionymus sagitta</i>	Arrow-headed Darter Dragonet	LC	-

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SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
23	<i>Channa gachua</i>	Dwarf Snakehead	LC	-
24	<i>Channa marulius</i>	-	LC	-
25	<i>Channa punctata</i>	Spotted Snakehead	LC	-
26	<i>Channa striata</i>	Snakehead Murrel	LC	-
27	<i>Chanos chanos</i>	Milkfish	LC	-
28	<i>Chelon melinopterus</i>	Otomebora Mullet	LC	-
29	<i>Cirrhinus mrigala</i>	Mrigal	LC	-
30	<i>Crenimugil seheli</i>	Bluespot Mullet	LC	-
31	<i>Dactyloptena gilberti</i>	Flying Gurnard	LC	-
32	<i>Dayella malabarica</i>	Day's Round Herring	LC	-
33	<i>Daysciaena albida</i>	Bengal corvina	LC	-
34	<i>Decapterus russelli</i>	Indian Scad	LC	-
35	<i>Devario fraseri</i>	Fraser Danio	VU	-
36	<i>Devario malabaricus</i>	Giant Danio	LC	-
37	<i>Ehirava fluviatilis</i>	-	DD	-
38	<i>Eleotris fusca</i>	Brown Spinecheek Gudgeon	LC	-
39	<i>Ellochelon vaigiensis</i>	Squaretail Mullet	LC	-
40	<i>Equulites leuciscus</i>	-	LC	-
41	<i>Esomus danica</i>	Flying barb	LC	-
42	<i>Etroplus suratensis</i>	Green Chromide	LC	-
43	<i>Eubleekeria splendens</i>	Splendid Ponyfish	LC	-
44	<i>Exyrias puntang</i>	Puntang Goby	LC	-
45	<i>Favonigobius reichei</i>	Indo-pacific Tropical Sand Goby	LC	-
46	<i>Garra mcclellandii</i>	Cauvery Garra	LC	-
47	<i>Gazza achlamys</i>	Smalltoothed Ponyfish	LC	-
48	<i>Gazza minuta</i>	Toothed Ponyfish	LC	-
49	<i>Glyptothorax annandalei</i>	-	LC	-
50	<i>Glyptothorax madraspatanus</i>	-	EN	-
51	<i>Gymnostomus ariza</i>	Ariza Labeo	LC	-
52	<i>Hippichthys penicillatus</i>	Beady Pipefish	LC	-
53	<i>Horabagrus brachysoma</i>	Günther's Catfish	VU	-
54	<i>Horaglanis alikunhii</i>	Alikunhii's Blind Catfish	DD	-
55	<i>Hyporhamphus xanthopterus</i>	-	VU	-
56	<i>Hypselobarbus dubius</i>	Nilgiri Barb	EN	-
57	<i>Hypselobarbus kolus</i>	Kolus Barb	VU	-
58	<i>Hypselobarbus mussullah</i>	-	EN	-
59	<i>Hypselobarbus thomassi</i>	Red Canarese Barb	CR	-
60	<i>Istigobius ornatus</i>	Ornate Goby	LC	-

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SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
61	<i>Kuhlia mugil</i>	-	LC	-
62	<i>Labeo bata</i>	Minor Carp	LC	-
63	<i>Labeo dussumieri</i>	Malabar Labeo	LC	-
64	<i>Laeops guentheri</i>	Günther's Flounder	LC	-
65	<i>Lamnostoma orientalis</i>	Finny Sand-eel	LC	-
66	<i>Lamnostoma polyophthalma</i>	Ocellated Sand-eel	LC	-
67	<i>Laubuka dadiburjori</i>	Dadio	LC	-
68	<i>Laubuka fasciata</i>	Malabar Hatchet Chela	VU	-
69	<i>Leiognathus equulus</i>	Common Ponyfish	LC	-
70	<i>Lepidocephalichthys thermalis</i>	-	LC	-
71	<i>Macrognathus guentheri</i>	-	LC	-
72	<i>Megalops cyprinoides</i>	Indo-Pacific Tarpon	DD	-
73	<i>Microphis brachyurus</i>	Opossum Pipefish	LC	-
74	<i>Monopterus albus</i>	Rice Swampeel	LC	-
75	<i>Monopterus eapeni</i>	Malabar Swamp Eel	DD	-
76	<i>Monopterus fossorius</i>	Malabar Swampeel	EN	-
77	<i>Monopterus javanensis</i>	Oriental Swamp Eel	LC	-
78	<i>Monopterus roseni</i>	-	DD	-
79	<i>Morone saxatilis</i>	Striped Bass	LC	-
80	<i>Mugil cephalus</i>	Flathead Mullet	LC	-
81	<i>Osteomugil cunnesius</i>	Longarm Mullet	-	-
82	<i>Chelon parsia</i>	Goldspot Mullet	-	-
83	<i>Mystus armatus</i>	-	LC	-
84	<i>Mystus gulio</i>	-	LC	-
85	<i>Mystus keletius</i>	-	LC	-
86	<i>Mystus montanus</i>	Wynaad mystus	LC	-
87	<i>Mystus oculatus</i>	Malabar Mystus	LC	-
88	<i>Mystus seengtee</i>	Shingtee	LC	-
89	<i>Nandus nandus</i>	-	LC	-
90	<i>Nectamia fusca</i>	Ghost Cardinalfish	LC	-
91	<i>Nemacheilus anguilla</i>	-	LC	-
92	<i>Nemacheilus denisoni</i>	-	LC	-
93	<i>Nemacheilus guentheri</i>	Gunther's Loach	LC	-
94	<i>Nemacheilus keralensis</i>	Kerala Loach	VU	-
95	<i>Nemacheilus nilgiriensis</i>	-	LC	-
96	<i>Neopomacentrus taeniurus</i>	Freshwater Damsel	DD	-
97	<i>Neotropius atherinoides</i>	-	LC	-
98	<i>Notopterus notopterus</i>	Notopterus notopterus	LC	-
99	<i>Oligolepis acutipennis</i>	Paintedfin Goby	LC	-

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SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
100	<i>Ompok bimaculatus</i>	-	NT	-
101	<i>Ophiocara porocephala</i>	Spangled Gudgeon	LC	-
102	<i>Oreichthys cosuatis</i>	-	LC	-
103	<i>Osteobrama bakeri</i>	Malabar Osteobrama	LC	-
104	<i>Parachiloglanis hogarti</i>	Torrent Catfish	LC	-
105	<i>Parambassis dayi</i>	Day's glassy perchlet	LC	-
106	<i>Parambassis thomassi</i>	Western Ghat glassy perchlet	LC	-
107	<i>Pellona ditchela</i>	Indian Pellona	LC	-
108	<i>Pisodonophis boro</i>	-	LC	-
109	<i>Planiliza macrolepis</i>	-	LC	-
110	<i>Planiliza tade</i>	Largescale Mullet	DD	-
111	<i>Platycephalus indicus</i>	Bartail Flathead	DD	-
112	<i>Plectorhinchus gibbosus</i>	Brown Sweetlips	LC	-
113	<i>Plicofollis dussumieri</i>	Blacktip Sea Catfish	LC	-
114	<i>Polynemus paradiseus</i>	-	LC	-
115	<i>Pomadasys argenteus</i>	Silver Javelin	LC	-
116	<i>Psammogobius biocellatus</i>	Sleepy Goby	LC	-
117	<i>Pseudapocryptes elongatus</i>	-	LC	-
118	<i>Pseudetroplus maculatus</i>	Orange Chromide	LC	-
119	<i>Pseudogobiopsis oligactis</i>	-	LC	-
120	<i>Pseudosphromenus cupanus</i>	Spiketail Paradise Fish	LC	-
121	<i>Pseudosphromenus dayi</i>	-	VU	-
122	<i>Puntius dorsalis</i>	-	LC	-
123	<i>Puntius vittatus</i>	-	LC	-
124	<i>Rasbora dandia</i>	-	LC	-
125	<i>Rasbora daniconius</i>	Slender Barb	LC	-
126	<i>Rasbora microcephalus</i>	-	LC	-
127	<i>Salmophasia balookee</i>	Bloch Razorbelly Minnow	LC	-
128	<i>Salmophasia boopis</i>	Boopis Razorbelly Minnow	LC	-
129	<i>Scatophagus argus</i>	Spotted Scat	LC	-
130	<i>Sicyopterus griseus</i>	Clown Goby	LC	-
131	<i>Siganus vermiculatus</i>	Vermiculated Spinefoot	LC	-
132	<i>Sperata aor</i>	Long-whiskered Catfish	LC	-
133	<i>Stenogobius gymnopomus</i>	-	DD	-
134	<i>Taenioides cirratus</i>	Whiskered Eel Goby	DD	-
135	<i>Tenualosa ilisha</i>	Hilsa	LC	-
136	<i>Terapon jarbua</i>	Tiger Perch	LC	-
137	<i>Terapon theraps</i>	Largescaled Terapon	LC	-
138	<i>Tetraoge nigra</i>	Freshwater waspfish	LC	-

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SN	Scientific Name	Common Name	IUCN Status*	WPA Schedule**
139	<i>Tor khudree</i>	Black Mahseer	LC	-
140	<i>Tor malabaricus</i>	Malabar Mahseer	EN	-
141	<i>Toxotes jaculatrix</i>	Banded Archerfish	LC	-
142	<i>Travancoria jonesi</i>	Travancore Loach	EN	-
143	<i>Wallago attu</i>	-	VU	-
144	<i>Zenarchopterus dispar</i>	Feathered River-garfish	LC	-
145	<i>Zenarchopterus ectuntio</i>	-	LC	-
146	<i>Zenarchopterus gilli</i>	Shortnose River Garfish	LC	-
147	<i>Zenarchopterus striga</i>	-	LC	-

*Status assigned by the International Union for Conservation of Nature and Natural Resources, where –CR – Critically Endangered; EN – Endangered; LC – Least Concern, NA – Not Assessed; NT – Near Threatened; and VU - Vulnerable.

**Schedules I to VI: Indian Wildlife (Protection) Act, 1972.

Sources: Ramsar Sites Information Service (2021). Information Sheet on Ramsar Wetlands (RIS), Vembanad-Kol Wetland. IUCN 2021. <https://rsis.ramsar.org/>; The IUCN Red List of Threatened Species. Version 2020-3; Schedules I to VI: Indian Wildlife (Protection) Act, 1972.

4.3.4 Habitat Profile of the Study Area

This section describes the habitat profile of the Study Area in terms of natural, modified and any potential critical habitats.

4.3.4.1 Natural Habitats

Natural habitats constitute approximately 10% of the habitat profile of the Study Area. These natural or near-natural habitats consist of an approximately 1 km long section of the Champakara River, a few slightly modified seasonal or perennial wetlands, as also, relic trees or small copses of species which are largely native with respect to the Study Area.

4.3.4.2 Modified Habitats

Modified habitats constitute approximately 90% of the habitat profile of the Study Area. These consist of mainly a highly modified near-contiguous sprawl of urban habitation, along with a few scattered patches of cultivation or disused farmland.

4.3.4.3 Critical Habitats

Habitats, either natural or modified, that are critical for the survival of IUCN Red Listed globally threatened, endemic or restricted range and migratory species are considered as Critical Habitat (CH). The Study Area may potentially contain Critical Habitat (CH) in terms of habitats supporting significant populations of any of the potential CH trigger species.

Potential CH Trigger Species

A preliminary screening of the species reported from the Study Area, against the applicable CH criteria, indicates that at least 33 potential CH trigger species have reported ranges that include the Study Area.

Table 4-22 presents details of these potential CH trigger species, including the scientific name of each species, the applicable CH criteria, its IUCN Red List status, global population, geographic range or extent of occurrence (EOO), known elevation limits and suitable habitat types.

Table 4-22: Potential CH Trigger Species of the Study Area

SN	Potential CH Trigger Species	Applicable CH Criteria	IUCN Status*	Global Population	EOO (km2)	Elevation (m)	Habitat Types**
1	<i>Bagarius yarrellii</i>	1b, 2a	VU	-	9387540	-	W

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SN	Potential CH Trigger Species	Applicable CH Criteria	IUCN Status*	Global Population	EOO (km2)	Elevation (m)	Habitat Types**
2	<i>Batasio travancoria</i>	1b	VU	-	16000-17000	-0.5 - -3	W
3	<i>Buceros bicornis</i>	1b	VU	13000-27000	10300000	0-2000	F
4	<i>Ciconia episcopus</i>	1b	VU	50000-249999	13000000	0-1400	F/G/W
5	<i>Crocodylus palustris</i>	1b	VU	5700-8700	-	420	W
6	<i>Cuon alpinus</i>	1a	EN	949-2215	-	0-5300	F/S/G
7	<i>Devario fraseri</i>	1b	VU	-	50000-60000	-	W
8	<i>Glyptothorax madraspatanus</i>	1a	EN	-	15000-20000	-	W
9	<i>Gyps bengalensis</i>	1a	CR	2500-9999	7370000	0-1500	F/S/G
10	<i>Gyps indicus</i>	1a	CR	30000	2150000	0-2000	F/S/G
11	<i>Horabagrus brachysoma</i>	1b, 2a	VU	-	15	-	W
12	<i>Hyporhamphus xanthopterus</i>	1b	VU	-	40000-50000	-	W
13	<i>Hypselobarbus dubius</i>	1a	EN	-	50000-60000	-	W
14	<i>Hypselobarbus kolus</i>	1a	CR	-	1000	-	W
15	<i>Hypselobarbus mussullah</i>	1b	VU	-	9387540	-	W
16	<i>Hypselobarbus thomassi</i>	1b, 2a	VU	-	10645-11000	-	W
17	<i>Laubuka fasciata</i>	1a	EN	-	-	-	W
18	<i>Lutrogale perspicillata</i>	1b	VU	-	-	0-700	F/S/G/W/C
19	<i>Macaca radiata</i>	1b	VU	-	-	0-1600	F/S/G
20	<i>Manis crassicaudata</i>	1a	EN	-	-	0-1850	F/S/G
21	<i>Monopterus fossilis</i>	1a	EN	-	15000-17000	-	W
22	<i>Nemacheilus keralensis</i>	1b, 2a	VU	-	7707	-	W
23	<i>Pseudosphromenus dayi</i>	1b, 2a	VU	-	14000-16000	-	W
24	<i>Pycnonotus xantholaemus</i>	1b	VU	2500-9999	359000	300-1800	F/S
25	<i>Rusa unicolor</i>	1b	VU	-	-	0-3900	F/S/G/W
26	<i>Sarcogyps calvus</i>	1a	CR	2500-9999	5230000	0-2500	F/S/G
27	<i>Sterna acuticauda</i>	1a, 3a	EN	6700-17000	4490000	700	W
28	<i>Syphoetides indicus</i>	1a	EN	1500	2160000	-	G
29	<i>Tor malabaricus</i>	1a, 2a	EN	-	70000-80000	-	W
30	<i>Travancoria jonesi</i>	1a, 2a	EN	-	4000	-	W
31	<i>Viverra civettina</i>	1a	CR	249	-	0-600	F/W
32	<i>Wallago attu</i>	1b	VU	-	10446620	-	W
33	<i>Zosterops palpebrosus</i>	1a	EN	-	14700000	0-4000	F/S

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SN	Potential CH Trigger Species	Applicable CH Criteria	IUCN Status*	Global Population	EOO (km2)	Elevation (m)	Habitat Types**
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*Status assigned by the International Union for Conservation of Nature and Natural Resources, where –CR – Critically Endangered, EN – Endangered and VU - Vulnerable.

**C – Coast, F – Forest, G – Grassland, M – Marine, S – Shrubland and W – Inland Wetland.

Sources: IUCN 2021. The IUCN Red List of Threatened Species. Version 2020-3.

Evaluation of the estimated global population, geographic range or extent of occurrence (EOO), elevation limits and suitable habitat types of each potential CH trigger species against the corresponding attributes of the Study Area and the criticality thresholds stipulated for the applicable CH criteria, indicates that the Study Area is less likely to contain, or be situated within, a CH with respect to the concerned species. Thus, the Project Site or the estimated area of influence of the Project are less likely to contain CH, or be situated within a CH, with respect to any of the potential CH trigger species reported from the Study Area.

4.3.5 Designated Areas

This section presents significant designated areas situated closest to the Project Site.

Designated Areas considered in this evaluation include nationally designated legally protected areas (LPA), such as National Parks (NP), Wildlife Sanctuaries (WLS) and Conservation Reserves, as well as, internationally recognized areas, such as Key Biodiversity Areas (KBA), Important Bird and Biodiversity Areas (IBA), Ramsar Wetlands, UN Man and Biosphere (MAB) Reserves and Alliance for Zero Extinction (AZE) Sites.

4.3.5.1 Legally Protected Areas

Mangalavanam Bird Sanctuary

The nearest legally protected area with respect to the Project Site is the Mangalavanam Bird Sanctuary, which is nationally designated as a Wildlife Sanctuary. It covers an area of approximately 2.74 ha of a natural mangrove forest.

As per the notification (dated 31 August 2004), conferring the designation, it was notified owing to ecological, faunal, floral and geomorphological importance, with the purpose of protecting, propagating or developing its wildlife and their habitat. The notification document states that the notified area contains significant diversity of mangrove species and is used as a roosting and nesting habitat by a significant number of resident and migratory bird species.

This legally protected area is situated approximately 7 km northwest of the nearest point on the Project Site boundary.

Paddy Lands and Wetlands of Nadama Village

The Project Site overlaps with a few minor legally protected areas, in the form of Paddy Lands and Wetlands, which are locally designated as per the provisions of the Kerala Conservation of Paddyland and Wetland Act 2008. The concerned lands are situated in Nadama Village, Kanayannur Taluk, Ernakulam district and identified as Survey. No. 480, 481 of Block No. 181/3 and Survey. Nos. 488, 489, 490, 491, 492, 493, 495, 495, 497, 498, 499, 500, 501, 502, 504, 505 of Block No. 182/1 of Nadama Village. The Project requires use of 0.54 ha of the said lands for construction of a viaduct as part of the Project.

As per the reviewed documents, the Client has been granted permission to convert 0.3482 Hectares of Paddylands towards construction of the said viaduct. However, in case of 0.1918 hectares of Wetlands (situated in Survey. Nos. 493, 496 in Block No. 182/1 of Nadama Village) involved, the Client has been granted permission to erect only 6 piers towards construction of viaduct, subject to the condition that minimum land required for the purpose shall be converted while preserving the existing land-use of the remaining land.

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4.3.5.2 Internationally Recognized Areas

The nearest internationally recognized area with respect to the Project Site is the wetland system of the Vembanad Lake, which is designated as a KBA and IBA, as well as, a Ramsar Site.

Vembanad Kol Wetlands Ramsar Site

The Vembanad Lake wetlands ecosystem, referred to as the Vembanad Kol Wetlands, is internationally recognized as a Ramsar Site. It represents a shallow estuarine network running parallel to the coastline of Kerala and opening into the Arabian Sea at Kochi and Azhikode. The Ramsar Site reportedly covers an area of 151,250 ha.

Several economically important species, including 80 species of fin fishes, 5 species of penaeid shrimps, 3 species of palaemonid prawns and 2 species of crabs are reported from the Vembanad Lake ecosystem (Asha et al., 2014). A traditional local mixed farming system, known as 'Pokkali', in which rice cultivation alternates with prawn culture annually, was reportedly practiced in many of these wetlands. In recent times, most such wetlands have reportedly been converted to other urban land-use, while some are being permanently used for prawn culture.

As per the datasheet provided by the Ramsar Site Information Service (RSIS), the location coordinates of the area designated as a Ramsar Site extend from 09 00 N to 10 40 N latitudes and from 76 00 to 77 30' E longitudes. However, the accompanying map indicates that the designated area is likely to extend eastwards only till approximately 76 30 E longitude.

Thus, as per the map available on the RSIS, the proposed Project Site, as well as, the estimated Area of Influence (AoI) of the Project appears to be situated within the area designated as a Ramsar Site. However, the concerned map does not provide adequate geo-referencing to enable confirmation of the same.

Note: The map available on the Protected Planet website depicts an area situated approximately 25-30 km east of the area depicted in the map available on the RSIS website and apparently unrelated to the concerned Ramsar Site.

Source: Ramsar Sites Information Service (2021). Information Sheet on Ramsar Wetlands (RIS), Vembanad-Kol Wetland. IUCN 2021. <https://rsis.ramsar.org/>; UNEP-WCMC (2021). Protected Area Profile for Vembanad-Kol Wetland from the World Database of Protected Areas, January 2021. Available at: www.protectedplanet.net;

Vembanad Lake KBA and IBA

An area of 79,400 ha area of the Vembanad Lake wetland system was accorded IBA status [IBA Code IN254] in 2004 owing to its significance as a congregatory site of 3 species - Anas querquedula, Chlidonias hybrida and Microcarbo niger, as well as, a habitat of a significant number of waterbirds as an avian group. An area of 59,359 ha of the Vembanad Lake IBA has qualified as a regional KBA, while being assigned priority for reassessment as a global KBA.

The central coordinates of the KBA site are: 9.60 N, 76.39 E. No part of the site is legally protected for crz value.

As per the maps available on the KBA website and BirdLife Datazone, the KBA and IBA areas largely overlap each other and are situated approximately 1.7 km from the nearest point on the Project Site boundary.

Source: Key Biodiversity Areas Partnership (2020) Key Biodiversity Areas factsheet: Vembanad Lake. Extracted from the World Database of Key Biodiversity Areas. Developed by the Key Biodiversity Areas Partnership: BirdLife International, IUCN, American Bird Conservancy, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Global Wildlife Conservation, NatureServe, Rainforest Trust, Royal Society for the Protection of Birds, World Wildlife Fund and Wildlife Conservation Society. Downloaded from <http://www.keybiodiversityareas.org/> on 19/01/2021; BirdLife International (2021) Important Bird Areas factsheet: Vembanad Lake. Downloaded from <http://www.birdlife.org> on 19/01/2021.

4.3.6 Ecosystem Services

This section describes the ecosystem services reported from or recorded in the Study Area, in terms of provisioning, regulating, supporting and cultural services.

4.3.6.1 Provisioning Services

The Champakara River, a section of which is situated within the Study Area and contains a part of Project Site, reportedly provides a moderate amount of priority provisioning services to local artisanal fisherpersons in terms of capture fisheries and navigable waterways.

The wetlands situated within the Project alignment are reportedly likely to be providing minor, episodic provisioning services, in terms of capture fishery, to local marginal fisherpersons.

4.3.6.2 Regulating Services

The Champakara River, a section of which is situated within the Study Area and contains a part of Project Site, is likely to be providing important regulating services in terms of water, sediment and nutrient regulation to the local community.

The paddylands and wetlands situated within the Study Area are also likely to be providing minor regulating services in terms of water regulation.

4.3.6.3 Supporting Services

The Champakara River, a section of which is situated within the Study Area and contains a part of Project Site, reportedly provides important supporting services in terms of breeding grounds and nurseries of several marine and estuarine species.

The paddylands and wetlands situated within the Study Area are also likely to be providing minor supporting services in terms of primary production and flood absorption.

4.3.6.4 Cultural Services

The Champakara River, a section of which is situated within the Study Area and contains a part of Project Site, is reportedly utilized by the local community for recreational purposes, especially in terms of a popular venue for traditional local snake-boat races.

4.4 Socio-economic Profile

4.4.1 Socio-Economic Environment

The section presents the socio-economic features of the project location. It attempts to depict the prevalent socio-economic conditions in the Project area and the area of influence using primary and secondary data sources. The secondary data is obtained from the Census Data 2011 and primary data has been gathered through consultations with the KMRL officials, local administration and people of the project area, who have been directly and/or indirectly impacted by the project.

4.4.2 Approach and Methodology

This section is based on the Terms of Reference (ToR) shared by ADB in September 2020, and subsequently a three days site visit was planned and undertaken in the month of November 2020. AECOM team also carried out desk review of documents obtained from KMRL and available in recommended official websites.

Methodology Adopted

- Identification of Project impacted area (direct and indirect Project impact area) in accordance with the Project site location. The Project site (including the footprint of associated facilities and associated activities) is defined as the direct impact area.
- A radius of two (02) kms from the Project site was earmarked as the Project area of influence (AoI) for the social baseline, for understanding the socio-economic environment and assessing social impacts due to the project;
- Interaction with the KMRL officials, other line departments, project site officials, contractors and labour working at the respective sites was undertaken on 3rd to 5th November 2020
- Individual interviews (IIs) and focus group discussions (FGDs) with the directly and/or indirectly impacted project affected people (PAPs) was carried out from 2nd to 5th November 2020.
- It was ensured that there is representation of women in the discussion groups, among KMRL staff, other project officials, from line departments, from among concerned PAPs and city dwellers interested in the project.
- Socio-economic baseline from the State level to village level was developed through discussion with project officials and community members . It is supplemented through secondary database available in the public domain.

The secondary data review undertaken for the study has been mentioned below.

Secondary Data Review

The following government publications (secondary database) were referred to while developing the socio-economic baseline for the study;

- DPRs – Detailed Project Report, Revised, Aluva – Tripunithura Nov 2018 and Detailed Project Report, Phase 1B, SN Junction - Tripunithura
- Reviewed two (02) SIAs shared by KMRL, done earlier for Vadakkekotta Station and Petta – Tripunithura Road widening Project, and EIA of Petta to Tripunithura Terminal.
- Project related data and information documents shared by KMRL
- Primary Census Abstract, 2011; Office of the Registrar General & Census Commissioner, India; Ministry of Home Affairs
- District Census Handbook, Ernakulam 2011
- Village Data Abstract 2011, Office of the Registrar General & Census Commissioner, India; Ministry of Home Affairs
- Economic Review 2019, State Planning Board, Thiruvananthapuram, Kerala, India

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- Report on the Socio-economic Status, Scheduled Tribes Development Department Government of Kerala November 2013
- Human Development Report, 2005 – Kerala
- National Family Health Survey (NFHS-4) 2015 -16, Kerala

4.4.3 Project Location Profile**4.4.3.1 State profile**

The state Kerala is on the southwestern coast of India. It is located between northern latitudes 8°18' and 12°48' and eastern longitudes 74°52' and 77°22'. It came into existence in November 1956, by putting together the Malayali speaking regions that covered Travencore-Cochin and Madras. It is bounded by Karnataka to the north and north-east, Tamil Nadu to the east and south and the Lakshadweep to the west.

Kerala's geographical area is 38,863 km² accounting for 1.30% of the total geographical area of India. It is the 21st largest state in the country by area and 13th largest state in the country by population.

Kerala State is divided in 14 districts, falling in six (06) regions – North Malabar (extreme north of Kerala), South Malabar (north-central Kerala), Kochi (Central Kerala), Northern Travencore, Central Travencore (southern Kerala) and Southern Travencore (extreme south of Kerala). Districts are further divided into 27 revenue sub-divisions and 77 Talukas.

Demographic Profile of Kerala

According to the 2011 census of India, Kerala State comprises of a population of 1210569573 individuals, where around 52.30% live in rural area and around 47.70% are urban dwellers. The state's population growth rate is much lower than the national average, the population stood at 31.8 million by 2001 and 33.3 million in 2011. The sex ratio in the state is 1084, much higher than the national average, which is around 950.

The literacy percentage of the state is 84.22%, of which the rural literacy stands at 51.71%, which is slightly lower than that of India, which is 63.22%. Interestingly, the rural literacy percentage is higher for the state as well as for the country. The male literacy rate is slightly lower in the state, which is at 48.71%, while the female literacy shown is 51.29%, unlike the national average, where male literacy is 56.93% and female literacy is 43.07%.

Table 4-23. Demographic Profile of Kerala State

Attributes	Number	India	% of India
Area (sq.km)	38,863	3,287,263	1.18
Total population	33406061	1210569573	2.76
Males	16027412	623121843	2.57
Females	17378649	587447730	2.95
Sex ratio	1084	950	NA
Percentage of rural population	17471135 (52.30%)	833463448 (68.85%)	NA
Percentage of urban population	15934926 (47.70%)	377106125 (31.15%)	NA
Population density (individuals per sq.km)	859	382	NA
Percentage SC population	9.10	201378086	NA
Percentage ST population	1.45	104281034	NA
Total literacy rate	28135824 (84.22%)	763498517 (63.07%)	NA
Male literacy rate	13704903 (48.71%)	434683779 (56.93%)	NA
Female literacy rate	14430921 (51.29%)	328814738 (43.07%)	NA
Rural literacy	14549320 (51.71%)	482653540 (63.22%)	NA
Urban Literacy	13586504 (48.29%)	280844977 (36.78%)	NA

Source: Census of India 2011

4.4.3.2 District profile

Ernakulam district is situated on the coast of the Arabian Sea. District headquarter is at Kochi, the only urban agglomeration with more than a million population is the commercial capital of the State. The district has Kerala High Court, Cochin Stock Exchange, and a major railway junction.. .

The district has 2 revenue divisions, the Fort Kochi and Muvattupuzha. The two administrative systems prevailing in the district are revenue and local self-government. Under the revenue system, the district is divided into revenue divisions, taluks and villages. Under the local administration, the district is divided into statutory towns and panchayats. For the implementation of development activities, panchayats are grouped under community development blocks. There are 7 talukas and 124 villages. The 7 administrative talukas in Ernakulam are Aluva, Kunnathunadu, Kochi, Kanayannur, Kothamangalam, Muvattupuzha and Paravoor. It has 01 Municipal Corporation, that is Kochi and 13 Municipalities.

Demographic Profile of Ernakulam District and Kanayannur Taluk

The district has 61 inhabited villages, with density population at 1072 per sq km. The literate population in the district is 95.89%. There are around 38.06% of workers, where 32.34% are main workers and 5.73% are marginal workers. A significant percentage of population are non-workers, showing 61.94%.

Project area comes under Kanayannur taluk. Kanayannur taluk a Census Town with 96.13% urban population. There are 38.13% in workers category and 61.87% in non-workers group. Around 89.42% represent main workers and 10.58% as marginal workers. Taluka literacy percentage (88.46%) is much lower when compared with district scenario but higher than the state, for both males (49.57%) and females (50.43%). The Taluka has 26 village locations.

Table 4-24. Demographic Profile of Ernakulam District and Kanatannur Taluka

Attribute	Tehsil: Kanayannur	District: Ernakulam	State: Kerala
Area (sq.km)	7.38	3063	38,863
Total population	851406 (25.94%)	3282388 (9.83%)	33406061
Males	418609 (49.17%)	1619557 (49.34%)	16027412 (47.98%)
Females	432797 (50.83%)	1662831(50.66%)	17378649 (52.02%)
Sex ratio (female per 1000 males)	1034	1072	1084
Percentage of rural population	32974 (3.87%)	1048025 (31.93%)	17471135 (52.30%)
Percentage of urban population	818432 (96.13%)	2234363 (68.07%)	15934926 (47.70%)
Population density (individuals per sq.km)	2809	1072	859
Percentage SC population	63536 (7.46%)	268411 (8.18%)	3039952 (9.10%)
Percentage ST population	3402 (0.40%)	16559 (0.50%)	484388 (1.45%)
Total literates	753139 (88.46%)	2855678 (95.89%)	28135824 (84.22%)
Male literates	373304 (49.57%)	1425723 (97.36%)	13704903 (48.71%)
Female literates	379835 (50.43%)	1429953 (94.46%)	14430921 (51.29%)
Rural literacy	29071 (3.86%)	908408 (31.81%)	14549320 (51.71%)
Urban Literacy	724068 (96.14%)	1947268 (68.19%)	13586504 (48.29%)
Workers	324640 (38.13%)	1249343 (38.06%)	11619063 (34.78%)
Non-workers	526766 (61.87%)	21786998 (65.22%)	2033045 (61.94%)

Source: Census of India 2011

4.4.3.3 The Project Study Area

Baseline data has been collected from the AoI, which has been determined to be 500 m. Following are the points that determine AOI for the social assessment:

- The project is primarily laying down metro rail line that also covers road widening work.
- The AoI falls on either side of the alignment.

The following locations are within the Area of Influence (AoI).

Table 4-25. Locations within 500 meters of AoI

District	Taluk (Sub-district)	AOI (Village/Municipal Council/Municipal Corporation)
Ernakulam	Kanayanoor	Poonithura in Kochi Municipal Corporation
		Chembakkara in Kochi Municipal Corporation
		Irambanam in Trippunithura Municipality
		Vadakkekotta in Trippunithura Municipality
		Tripunithura in Trippunithura Municipality
		Eroor in Trippunithura Municipality
		Kottakkom in Trippunithura Municipality
Total number of Locations		7

Source: Census of India 2011

There are seven (07) locations that fall within 500 mts of project location. Out of these seven locations, two (02) locations belong to Kochi Municipal Corporation and remaining five (05) are part of Tripunithura Municipality. Map is indicative of the Project study area and the area of Influence has been illustrated in Figure 4-1.

4.4.4 Demographic profile of the Study Area

A section of the Kochi Metro Rail project covering a distance of three (03) kms that falls in two local administrative divisions- the Municipal Corporation Kochi and the Municipality Tripunithura, where project impact is envisaged. Combining the Kochi municipal corporation and Trpunithura Municipality population, total number of literates are 362143, 156264 are workers and 249174 are non-workers.

Table 4-26. Demographic Profile of AOI

Area of Impact	Area in km ²	HH	Population	Sex Ratio	SC	ST	Literacy	Worker	Non-worker
Kochi	107.13	87252	336048	1027	13172	1437	299888	128564	207484
Tripunithura	29.17	29495	69390	-	6547	166	62255	27700	41690
		116747	405438		19719	1603	362143	156264	249174
Taluk - Kanayannur	7.38	2346	851406 (25.94%)	1034 (7.46%)	63536 (0.40%)	3402 (88.46%)	753139 (38.13%)	324640 (61.87%)	526766
District - Ernakulam	3063	814011 (9.83%)	3282388	1072 (8.18%)	268411 (0.50%)	16559 (95.89%)	2855678 (38.06%)	1249343 (34.78%)	21786998 (65.22%)
State - Kerala	38863	7853754	33406061	1084	3039573 (9.10%)	484839 (1.45%)	28135824 (84.22%)	11619063 (34.78%)	2033045 (61.94%)

Source: Census of India 2011

4.4.4.1 Population level

The district represents 9.83% of states population, where the Taluk – Kanayannur represent around 25.94% of the district population. State level census data indicate women population (52.02%) to be more than men (47.98%). At the district level, representation of men (49.34%) and women (50.66%) is not very wide, this is probably because Kerala state has matriarchal system, where acceptability of girl child is not a problem issue as in other parts of Indian states. The scenario is quite similar at the Taluka level as well.

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Table 4-27. Population by Religion

Religion	Kerala	Ernakulam	Kanayannur	Cochin	Tripunithura
Hindu	54.73%	45.99%	53.16%	43.78%	82.78%
Muslim	26.56%	15.67%	11.91%	17.56%	1.35%
Christian	18.38%	38.03%	34.49%	38.12%	15.28%
Sikh	0.01%	0.03%	0.04%	0.08%	-
Jain	0.01%	0.04%	0.05%	0.17%	-
Buddhist	0.01%	0.02%	0.02%	0.04%	-
Others	0.02%	0.03%	0.05%	0.06%	-

Source: *Census of India 2011*

The project location has followers of three (03) major religions, that being Hinduism, Islam and Christianity, the other religions in minority are Sikhism, Jainism, Buddhism. The percentage of Hindus seem to be highest in the State (54.73%), District (45.99%), at Taluk level (53.16%) as well as the study areas Kochi (43.78%) and Tripunithura (82.78%). At the state level Muslim population stood second (26.56%) but in District level (38.03%), Taluka (34.49%) and study area Christian population was found more than Muslims at 38.12% for Cochin MC and 15.28% for Tripunithura M.

4.4.4.2 Social stratification: Vulnerable groups, SCs and STs

There is no structured definition of vulnerable population of India provided by the Indian Constitution. The definition as provided by the Planning Commission's Working Group Report on SC/ST describes the vulnerable groups as the people "that face discrimination in all spheres of life include Women, Scheduled Castes (SC), Scheduled Tribes (ST), Children, Aged, Disabled, Poor migrants, People living with HIV/AIDS and Sexual Minorities". The ninth Five Year Plan brings in a category of vulnerable population and termed it as Below Poverty Line (BPL), now there are government schemes that include identified BPL population to earn benefits from the schemes. ADB in its Safeguard Policy Statement 2009, describes vulnerable population as, "especially those below the poverty line, the landless, the elderly, female headed households, women and children, Indigenous Peoples, and those without legal title to land".

Kerala state has very low percentage of tribal population, that is indicated as 1.45%. SC population at the state level is also very low, indicating only 9.10% but little higher than ST population. The percentage of ST population at District (0.50%) and Taluka (0.40%) level is even lower, as is the case of SC population - at District (8.18%) and Taluka (7.46%).

The detail list of PAPs of the study area as prepared by the SIA conducting agencies does not include all required categories of ADB – SPS, as a result impact assessment on vulnerable categories as per ADB requirement can not be determined. However, the SIA reports for Vadakkekota Station area indicated that there are no SC and ST families in the impacted population, there are 12 women property owners but no details on how many are women headed household (WHHs). The SIA report for Petta – Tripunithura (Road Widening) Project it is indicated that, there from the 1245 total affected persons, 269 children, 239 elderly, 80 widows, 58 (widow) women are the head of their families, along with 5 physically and 2 mentally challenged persons have been put in the vulnerable PAP category.

4.4.4.3 Gender Profile

Gender disparity has been a common feature in development projects world over, the feature though has been very common in developing countries and more intense in under-developed countries. Involving women in development initiatives is quite a recent phenomenon. Over the years now, there is more and more demand for women inclusion in development efforts within the country. Women's need assessment are being assessed, their participation and involvement in different stages of development programs is being encouraged and women specific project benefit analysis is also being undertaken. The Kerala state has introduced a number of innovative schemes and programmes for the upliftment of women in the state. Some of such schemes are - Anganwadi Karyakatri Bima Yojana; Integrated Child Development Services Training Programme; Ujjawala; Flagship Programme for Gender Awareness; Flagship Programme on Finishing School for Women; Educational Assistance to Children of Women Headed Families; Vocational Training to Inmates of Women Welfare Institution through STED; Nutrition Supplement to HIV affected Women and Children; Implementation of Domestic Violence Act, 2005; Implementation of Dowry Prohibition Act, to mention only a few.

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Kerala being an only example of enjoying matriarchal family system in the entire country, the indices of women's wellbeing, such as sex ratio, literacy percentage, employability, infant mortality, female foeticide, women's health issues, decision making power, etc. show much better results when compared with rest of India. Discussion with local people and PAPs, involving women as well, it was revealed that birth of a girl child is welcomed in family/society, no discrimination among boys and girls for sending them to school, women are involved in variety of decision making issue – their education, professional career, marriage age, child birth and spacing decision, in property matters, travel plans, etc. They do get the decision-making power. Some women did also mention that they sometimes have the veto power as well on decision of others. All women and others involved in the discussion said that women in their family have separate (as well as joint) bank accounts and financial investment policies.

The data analysis of the project study area, in Table 4-26 and Table 4-27, indicates that the female population is more than males, though no significant difference is noted among male and female population in the state, district and the concerned taluka. The sex ratio indicated that number of females is more than males in state, district as well as Taluka. The female (50.43%) literacy percentage is more than males (49.57%) in the taluka, similar percentage difference is observed in State level data where 48.71% of males and 51.29% females are literates. The difference though not wide, percentage of literate men (97.36%) at District level is more than literate females (94.46%). The percentage of females (26.90%) entering into workforce is much less than males (73.10%). Females percentage (65.26%) is almost double to that of males (34.74%) as non-workers. More females are into marginal workers category (46.53%) than into main workers category (23.43%), where more males are found to be in main workers (76.57%) category than marginal (53.47%).

4.4.5 Education level

Kerala was the first Indian state to achieve 100 literacy in 1991, and district Ernakulam became the first fully literate district in 1990. The Kanayannur taluk shows literacy percentage to be at 88.46% where 49.57% are male literates and 50.43% are female literates. At the district level, around 95.36% are found literates with 97.36% of males and 94.46% as female literates.

The project location has number of educational institutions, from primary schools, to senior schools, colleges and technical institutes. Coaching centres for different levels and different course works are also available.

Discussions on value of education among locals indicated that people generally complete till graduation, many got for even higher studies outside the state and many more have moved out of country for better education. There is no bias or gender difference concerning provision of education facilities to both boys and girls in the family.

4.4.6 Occupation and Livelihood

Consultations with the project affected persons and people contacted in and around the project location, indicated that majority of people are involved in government and private services. A significant percentage of population runs business, small, medium big from fruit seller to general store owner to showroom owner. The project area has number of restaurants/eateries, a common source of livelihood in the area. Consultations revealed that women are more into services, that may be in government sector or private sector. Men are more involved into business and privately-owned consultancies and other professions like doctors, advocates, school tuitions, etc.

4.4.6.1 Workforce Participation Rate

Section below presents the work profile of the Taluk (sub-district), as provided in the Census Handbook, considering categories such as workers and non-workers and among workers – main and marginal workers¹, where sub-categories are cultivators, agriculture labours, household industries and other workers.

Table 4-28 indicates workforce participation scenario in the District.

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Type	Total	Male	Female
DISTRICT Population - 3282388			
WORKERS	1249343 (38.06%)	913249 (73.10%)	336094 (26.90%)
Main workers ²³	1061388 (84.96%)	812754 (76.57%)	248634 (23.43%)
Marginal workers	187955 (15.04%)	100495 (53.47%)	87460 (46.53%)
NON-WORKERS	2033045 (61.94%)	706306 (34.74%)	1326737 (65.26%)

Source: Census of India 2011

In the district 30.06% fall in the workers category and 61.96% in the non-workers category. There are 73.10 % males and 26.90% females represent the working class, whereas 34.74% males and 65.26% in the district are non-workers. Percentage of non-workers is quite high in the district. The typical work scenario, that more men than women are in the workforce, and more women are in the non-working category. More men are in the main work category and more women fall in marginal work category.

4.4.6.2 Land use pattern

The project impact area being part of Kochi Municipal Corporation and Kanayannur Municipality, agriculture is not prominent in the close vicinity of the project location. Though discussion with PAPs indicated that some of them have agricultural land far away from the project location in the same district, where primarily paddy is cultivated. Other crops/fruits grown are coconut, cashew, banana, jack fruit, arecanut, tapioca and pepper. As mentioned by PAPs, production from agricultural land is an additional source of income for majority of city dwellers. It was also indicated that the project activities have no impact on any agricultural land.

Land parcel near Tripunithura station was reported to be used for Paddy cultivation around 15-20 years back. Now the area has no paddy cultivation.

4.4.6.3 Irrigation

Discussion with KMRL officials and concerned PAPs revealed no irrigation facility is available in absence of large-scale agriculture activities in Aol.

4.4.7 Physical Infrastructure and Civic Amenities

The project location being in a major corporation/municipality area, it has organised and maintained basic infrastructures and amenities. The project activities lead to traffic congestion at times but not long duration blockade. In some locations the inner locality ROWs have been blocked, but they all have been provided with alternative passage. At some locations the foot paths have been lost due to road widening work. Traffic marshal are provided to assist the local travels for safe and smooth movements.

4.4.7.1 Drinking Water

The entire project area is connected to pipe water supply scheme. The source of city water supply comes from Kerala Water Authority (KWA). The water supply is 24 hr 7 days week.

4.4.7.2 Electricity Supply

The entire project area has electricity supply, that runs through the day with intermittent power cuts.. The entire project stretch has electricity poles in working condition. The supply comes from Kerala State Electricity Board (KSEB). There is 24 hrs 7days week supply of electricity.

4.4.7.3 Sanitation Facility

All households have inhouse toilet connections. As reported, the area has three (03) community /public toilets, maintained by the Municipal Corporation. The petrol pumps have toilet provisions for

²³ Main workers are those who have been engaged in economically productive activities for more than one hundred eighty-three (183) days and Marginal workers are those workers who have been engaged in any economically productive activity for less than one hundred eighty-three days (183) days.

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public use Consultation with local people indicated that people approach the nearby hotels/restaurants for toilet use.

There is regular garbage collection by the Municipal Corporation/Municipality.

4.4.7.4 Health Profile and Infrastructure

Project being in a major corporation and municipal area, there are ample health care facilities within a radius of $\frac{1}{2}$ to 1 kms, with some facilities operating 24 hrs 7 days week. There are number of hospitals, clinics and health centres in close vicinity. It is ensured that passage to health service centres remain cleared at all times. There used to be cases of malaria, dysentery etc. now the percentage has gone down significantly. The recent pandemic being COVID, awareness programs have been carried out at city level as well as at project location.

4.4.7.5 Banks and Post Offices

Major banking facilities are present within the city and municipality area of Kochi and Tripunithura. Few ATM's from prominent public and private sector banks were observed to be present within the study area.

4.4.7.6 Communication System

There is telephone connectivity and good mobile phone coverage. There are three (03) post offices in the project study area. There are around seven (07) local newspapers in local language. There are local editions of other newspapers like The Times of India, The Hindu and The Indian Express.

4.4.7.7 Transportation and Roads

The project location has well-constructed metaled roads connecting localities and places.. The location is connected well through public and private means of transportation. There are state transport services, private taxi and auto services. There are small level boat/ferry services as well in canal.

4.4.7.8 Shops and Market Complexes

Kochi is a prominent city area in the district and has facilities of vendors, markets, shopping complexes, malls and showrooms for all variety of requirements within $\frac{1}{2}$ km to 2 kms. The project stretch actually has shops on either side of the project road.

4.4.7.9 Religious Sites

The project stretch has many religious structures – temples, mosques and Churches. There were three temples, two churches and one mosque in Aol. Construction work impact on the Shree Poornathrayeesa Temple, during festival time in November particularly is managed by the local administration. Shiva temple in Tripunithura area where portion of temple boundary was affected, due compensations have been paid to the Temple Trust. Sree Vaishnava Gandharva Temple at Chambakkaran lost its boundary and parking area, compensation amount paid to the trust. Mosque at Poonithura area lost parking and the boundary due to road widening work, the mosque authorities have been paid the compensation amount. ST George Church at Tripunithura lost land for which the compensation amount has been paid. In addition, the church on its front side had Saint's statue that needed to be shifted, the shifting was done by the project. Another church at Upasana Nagar area that has been impacted by the project in relation to land loss. Other notable religious sites are Chakkamkulengara Temple which is located at approximately 600m from the alignment.

5. Stakeholder Participation and Consultation

Stakeholder consultations are essential segment of any development program. It provides transparency, successful achievements and sustainability to the development initiatives. It is a two-way dialogue between the Project proponent (managers, implementers, developers) and the stakeholders (who can affect and get affected).

The AECOM team visited the project site from 2nd November to 5th November 2020 and undertook site visit and consultations with project managers, employees, contractors, labours, project affected persons and others interested in Kochi Metro Rail project. The participant attendance sheet has been attached in **Appendix C**.

5.1 Approach and Process of Stakeholder Engagement

The stakeholder engagement and consultation process have the following objectives:

- To ensure timely and consistent disclosure of Project information to all stakeholders and facilitate their feedbacks, concerns and decisions;
- To assess the Project impact on future developments plans in the Project area;
- To estimate impact of project on the community and community influence on the project's successful completion;
- To provide opportunities to the affected communities to express their views on the Project, and its impact on well-being of impacted property owners;
- To create a sense of belongingness and ownership among the community (beneficiaries) for the project outcome by involving them in different phases of project; and
- To ensure a process by which any grievance, suggestions or general feedback are accepted and addressed in a timely manner and incorporated in the Project where applicable and relevant.

Consultations conducted during the ESIA stakeholder engagement process involved individual interviews, focus group discussions and online discussions considering COVID-19 related restrictions in face to face meetings. The following aspects form the structure of consultation process adopted for impact assessment:

- Verification and validation of proposed site
- Identification of the relevant stakeholders including all those individuals, groups and organizations potentially influenced by or interested in the Project;
- Information disclosure about the Project and identification of its potential impacts on livelihoods of locals;
- Review and validation of project documents;
- Understanding the project implementation and management procedures being followed.

The discussion process involved an open ended and structured discussions with different categories of stakeholders, individuals as well as in groups being directly and indirectly affected by the project.

5.2 Stakeholder Identification, Categorization and Mapping

The project consists of range of stakeholders with varied interests and influence in the project. A stakeholder is 'a person, group or organization that has a direct or indirect stake in project because it can affect or be affected by the project/ project proponent actions, objectives and policies. Thus, they vary in terms of degree of interest, influence and control they have over the project.

Primary stakeholders are those stakeholders who have direct impact or are directly impacted while those are indirectly impacted by the project are the secondary stakeholders. The details of project associated impacts as gathered through the consultation process from the affected stakeholders have

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been elaborated in the subsequent section. For the purpose of the study, consultations were undertaken with the KMRL officials, concerned line departments, contractors and sub-contractor, workers at the construction location, the PAPs - residents in the project study areas, etc..

Table 5-1: Stakeholder Mapping

Stakeholders*	Primary Stakeholders	Secondary Stakeholders
Project Proponent	Kochi Metro Rail Ltd.	-
Government Departments	<ul style="list-style-type: none"> • Land Revenue Department • RTI Department, Ernakulam 	<ul style="list-style-type: none"> • Fisheries Department • Agricultural Department • Irrigation Department • Forest Department
Government Bodies	<ul style="list-style-type: none"> • Kochi Municipal Corporation • Tripunithura Municipality • State Pollution Control Board 	-
Contractors/ Sub-contractors	<ul style="list-style-type: none"> • (KEC) • (CCECC) • (VNC) 	-
Local Community	<ul style="list-style-type: none"> • Land Sellers • Individuals with livelihood & structural loss • Individuals with indirect project impact 	City dwellers, regular travelers/ daily commuters
Others	Traffic controllers at project sites	<ul style="list-style-type: none"> • Construction labors at Casting Yard in Kalamassery & at Material Storage Yard, Irumpanam • Individuals interested in project components

* It was ensured that all stakeholder groups have women representatives during consultation & discussions.

The following table is indicative of the stakeholder engagement activities carried out for the Project including date and nature of engagement, location and the number of attendees.

Table 5-2: Stakeholder Engagement Details

Stakeholder	Date	Venue	Number of Participants	Mode of Consultation
Project Proponent	03.11.2020	KMRL Office	20+	Presentations and open group discussion
		<ul style="list-style-type: none"> • Fisheries Department • Agricultural Department • Irrigation Department • Forest Department • Land Revenue Department • RTI Department, Ernakulam 	Around 10	Individual interview
Government Departments	04.11.2020		Around 25	Individual interview & focus group discussion (FGD)
Contractors/ Sub-contractors				
Representatives of KEC, CCECC & VNC	03.11.2020	<ul style="list-style-type: none"> • Construction Site Offices • KEC Office 	<ul style="list-style-type: none"> • Around 16 • Around 18 	<ul style="list-style-type: none"> • Individual interview & FGD
Local Community				
Local community in the project study area	02.11.2020	Project site surrounding areas.	Around 15	Individual interview & FGD

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Stakeholder	Date	Venue	Number of Participants	Mode of Consultation
PAP & others from local community	03.11.2020 & 04.11.2020	Stretch from Petta to SN Junction and SN Junction to Tripunithura	Around 37	
	05.11.2020	Chambakkaran, Petta, Poonithura area	Around 23	
Others				
<ul style="list-style-type: none"> • Traffic Controller at project sites • Construction Labors 	03.11.2020	Road stretch – Petta to SN Junction	02	<ul style="list-style-type: none"> • Individual interview
	03.11.2020	Casting Yard, Kalamassery	Around 09	
	03.11.2020	At Milma Milk Parlour	02	<ul style="list-style-type: none"> • FGDs
	04.11.2020	Material Sorage Yard, Irumpanam	Around 15	
	04.11.2020	Site-Metro Track, Tripunithura	03	

5.3 Stakeholder Analysis

The table below presents the influence and interest level of the identified stakeholders, who may impact on the project and may get impacted by the project, directly or indirectly.

Table 5-3: Stakeholder Significance and Engagement Requirement

Influence on/by Stakeholder			
	Low	Medium	High
Magnitude of Interest	<ul style="list-style-type: none"> • Fisheries Department • Agricultural Department • Irrigation Department • Forest Department 	<ul style="list-style-type: none"> • RTI Department, Ernakulam • Construction labors 	<ul style="list-style-type: none"> • Traffic controllers at project sites • City dwellers, regular travelers/ daily commuters
		<ul style="list-style-type: none"> • Kochi Municipal Corporation • Tripunithura Municipality 	
	<ul style="list-style-type: none"> • Individuals interested in project components • State Pollution Control Board 	<ul style="list-style-type: none"> • Kochi Metro Rail Ltd. • Land Revenue Dept • KEC / CCECC / VNC • PAPs - Land Sellers • PAPs – livelihood/structural loss • PAPs - indirect project impact 	

The inclusion of stakeholders as mentioned above includes person, groups, institution or organization that is likely to be impacted (directly or indirectly) by the project or may have interest/influence over the Project. Since the it is a long-term project, its influences on people and people's influence on its successful functioning needs to be assessed at regular intervals.

Implications of interest magnitude level and corresponding influence level

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Low Magnitude and Low Influence -

This indicates that the extent of influencing power of the stakeholders on the project and vice versa are low, since there is no agricultural land, forest land and/or fishing area is being impacted upon. The project is not going to affect them much, neither they are going to influence the project activity.

Low Magnitude and Medium Influence -

This implies that the concerned stakeholders have low direct interest in the project but may impact on its successful completion depending on extent of its involvement. But once involved, it may have repercussions on the project outcome.

Medium Magnitude and Medium Influence -

Having medium level interest, where there is indirect involvement in the project activities, the influencing power stays at minimum unless the project outcome directly benefits the stakeholders.

High Magnitude and Medium Influence -

The interest level may be high but influencing power depends on the extent of engagement in the project activities. Its need (SPCB) and recognition (for interested individuals) by other stakeholders.

Medium Magnitude and High Influence -

The degree of interest may be low, but their involvement has significant role in influencing the successful completion and sustainability of project outcome.

High Magnitude and High Influence -

This specifies that the concerned stakeholder's high-level interest in its need assessment, project design, its implementation, effective monitoring, intermittent evaluation and successful completion has significant role in influencing as well.

5.4 Stakeholder Consultation

Stakeholder consultation has been adopted as a standard practice of involving project proponents and the beneficiaries in all development projects. This primarily helps to understand the status of the project and extent of benefits reaching the PAPs. In the present context, consultation was undertaken with KMRL, employees and workers at the sites and the direct/indirect beneficiaries of the project, through interviews and FGDs.

The table below presents the key features and outcomes of the discussions held the project. The detail consultation is provided in Annexure B.

Table 5-4: Key Consultation Issues

Stakeholders	Key Issues	Key Responses
Project Proponents – KMRL	<ul style="list-style-type: none"> • Project information • Project related Social & Environmental Issues • Grievance Redressal Mechanism 	<ul style="list-style-type: none"> • LARA Act 2013 was strictly followed for land acquisition • Land acquisition for Phase 1B is waiting for administrative sanction. • There was no unclaimed land falling in the required land for the project. • KMRL is the owner of viaduct and stations only, for other properties the ownership is only to the extent of project duration. • Land from Railways also to be procured, agreement in process, as per Railway Policy it will be on lease for 75 years. • There are PAPs impacted twice due to the project. • KMRL is the owner of viaduct and stations only, for other properties the ownership is only to the extent of project duration.

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Stakeholders	Key Issues	Key Responses
		<ul style="list-style-type: none"> • LA and compensation related grievances are settled as per LARA Act. • Organisational structure and key departments, • Recruitment and retrenchment processes, • Internal grievance redress system and processes, • Contractor management responsibilities (Collective bargaining for employees and workers, contract agreements, reporting requirements for compliance etc.), • Anti-sexual harassment system and procedure, • The management discussions were followed by employee consultations, to understand awareness of systems and procedures.
Land Revenue Department officials	<ul style="list-style-type: none"> • National & State Land Acquisition Policy • The procedure of LA and R&R • Grievance Redressal Mechanism 	<ul style="list-style-type: none"> • The LA office is strictly following the LARR Act 2013 for settling R&R issues and paying compensation to PAPs and the land acquisition. • Formal notification served by GOK is the cut-off date. • All affected are categorized as PAPs, there is no separate category of vulnerable PAPs. • Government notification is issued informing locals for land acquisition and R&R issues. • There is declaration award enquiry where Detailed Valuation Statement (DVS) papers, signed by collector is presented in the discussion forum, shared with PAPs • To calculate the land value, cost considered is double the present market value along with last three (03) years average. • There had been individual meetings with PAPs, and public meetings/hearings were organized to listen to grievances and demands of affected public. • As part of LA process relevant documents are requested from the PAPs, when furnished, on verifying the reliability & validity of documents and verification from village records/ corporation records, the compensation amount is deposited in PAPs a/c. • Instances of incomplete documentation and stay due to litigation the compensation amount is deposited at DC office. • Onetime payment is made to PAPs, there is no monitoring of their (PAPs) re-establishments. • There is no separate shifting assistance, it is covered in the solatium paid to PAPs. • People – owners/rentee/others fall in the category of PAPs, only if they are residing/occupying the place for three (03) or three plus (03+) years. People staying for less than three years do not get any compensation/solatium. • No compensation paid to encroachers and non-titleholders, only livelihood compensation is paid, if stationed at the location for three or more than three years.

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Stakeholders	Key Issues	Key Responses
Employees/Staff of Contractor/ sub-contractors	<ul style="list-style-type: none"> • Project information • Project related Social & Environmental Issues • Challenges & problems faced • Grievance Redressal Mechanism 	<ul style="list-style-type: none"> • In case of compensating for commercial set up, it must be the primary source of income, then only livelihood loss is compensated. No compensation if PAP has alternate or more than one source of income. • In case of temporary acquisition, the area (space) is restored back to best possible extent while returning to the owner.
PAPs	<ul style="list-style-type: none"> • About KMR Project • LA and R&R Issues • Impact of construction work • Grievance Redressal Mechanism 	<ul style="list-style-type: none"> • There are some locations where access / ROW is temporarily blocked, an alternate passage has been provided. • In case of emergency the work is stopped, and passage cleared • During accident and medical emergency cases at the construction site, there is tie-up with VKM Hospital and KEC Int. Ltd, which is open 24x7 • There are training programs held every day for 15 minutes from 0830 hours to 0845 hours. Trainings have been on – building safety, welding safety, lifting heavy objects, electrical safety, housekeeping and also COVID 19 precautions and care. • Construction work goes on 24 hours in two (02) shifts, from 0830 hours to 2030 hours and from 2030 hours to 0830 hours. • No women labours have been employed, since work involves.
Locals/ Residents /Travelers	<ul style="list-style-type: none"> • KMR Project • Impact of Construction Work • Grievance Redressal Mechanism 	<ul style="list-style-type: none"> • Happy about the upcoming project, good for people • There is regular water sprinkling to suppress the dust flow. • Mainly the parking areas of shops, religious places have totally gone. • There are often vibrations, and the sound sometime falls very heavy on head. • Reduced parking area has affected the number of visitors and that impacted on livelihood. • KMRL is doing good job and managing project activities with well, with safety and security. • Not heard of major accidents due to the construction work. • There should have been some kind of community consultations with city people for decision on station locations. • Foe few, the acquired property was the only source of income. • Some of the PAPs were not happy woth the compensation amount paid. Few others have put their issues in court for settlement. • There are few landless PAPs. • Few shops had to remain closed for six months.

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Stakeholders	Key Issues	Key Responses
Labours at work sites	<ul style="list-style-type: none"> • Provisions at Project Sites • Other facilities • Challenges & problems faced • Grievance Redressal Mechanism 	<ul style="list-style-type: none"> • Meal ration is provided by the contractor, but labours cook themselves. • Camp site has drinking water facilities, proper toilets and bathing areas. • There has been no health check-up, neither for COVID19. • The construction site has no rest shelter, drinking water and toilet facility. They go to nearby restaurant. • Not aware of any training programs, on safety issues or any other

Source: Site Visit



03.11.202 – Discussion on Project with KMRL Staff



03.11.202 – Consultation with Site In-charge



04.11.202 – Discussion with land Revenue Dept Officials



04.11.202 – Discussion with Labours at Construction Site



05.11.202 – Consultation with Women PAPs



05.11.202 – Consultation with Fishermen at Chaambakaran

5.4.1 Past Stakeholder Engagement Activities

Multiple public meetings and hearings as part of the land acquisition procedure stipulated by the law under section 5 chapter 2 and section 15 chapter 4 of the RFCTLARR Act 2013 were conducted by LA team. The main goal of these public hearings was to disseminate information with respect to project land, affected entities, results of SIA studies, provisions made under R&R and to receive support, objections or feedback from the project affected people. Although details of dates and minutes of the public hearings are yet to be shared with AECOM, it is understood that public hearings for road widening works were conducted between 2017 and 2018 whereas the public hearings for Vadakkekotta station were conducted in 2019 and 2020.

Information shared about the two meetings held on 2nd September 2017 and 19th November 2019 for road widening and Vadakkekotta metro station respectively, indicate the following key aspects about the hearings:

- Notification for public hearing were given through notices to all affected families a month prior to the hearing and published in two Malyalam newspapers 2 weeks prior to the hearing. The SIA unit intimated KMRL and all the relevant government departments including the Deputy Collector, Tahsildar office, Village offices of Poonithura and Nadama, Tripunithura Municipality, Kochi Corporation etc. about the hearing. Notices were also displayed at various public places to create general awareness about the hearing too.
- The discussions between the participants of the hearing were transcribed in the local language.
- The locals demanded that least disturbance was caused to the Champakara market while construction of bridge over the canal.
- Some of the concerns expressed by project affected persons are:
 - business owners requested if their parking space can be spared from the land acquisition because it has direct impacts on their business (livelihood). They were informed that the project land requirement could not be changed because it has been finalised considering various technical aspects,
 - residential structure owners expressed their concerns over partial demolition of their structures leading to an unusable property or even damage to the entire structure. Therefore, they demanded for appropriate compensation for the loss instead of the part of structure needed to be demolished for the project,
 - religious structures of significance were demanded to be relocated to a different place,
 - some of those losing parking area, would be facing livelihood losses as the parking area was the primary income source; thus they wanted to be compensated appropriately,
 - alternate land or commercial structure was requested as a means of compensation for loss of a similar structure.

These projects affected persons were suggested to submit their claims to the LAO once the acquisition process begins. In some cases, the business owners were suggested to put a claim

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for 100% acquisition of the land if the proposed acquisition is for more than 50% of the land. The request for land-for-land was denied.

- Those who were impacted for the second time by the land acquisition for Vadakkekotta station demanded they receive a special package of R&R due to their second time impact,
- Some locals demanded that the water drainages and sub-roads to be restored,
- It was brought to notice by some participants that workers employed at the commercial establishments impacted by the project are also project affected and should be considered for appropriate compensation.

The persons affected twice, first by the road widening and for the second time by the station related land acquisition, were paid compensation for all the losses incurred both times separately. The drainage line on both sides of the road was repaired. And workers at commercial establishments were considered for compensation of INR 36,000/-.

- Some of the suggestions came by post and were responded to by the SIA unit. For example, the Kottakkakam Residents Association suggested that the Petta bridge should be reconstructed with additional width and pavement facility; the metro should be extended up to Thripunithura terminal; and the byroads should be strengthened to avoid increased traffic congestion.

Discussions with the project affected persons on-site indicate that separate public hearings were held for titleholders and non-titleholders to ensure focused communication and productive discussions.

In addition to the public hearings, the preliminary notification of acquisition under section 11 chapter 4, the hearing of objections with the District Collector under section 15 chapter 4, publication of declaration of summary of Resettlement and Rehabilitation Scheme under section 19 chapter 4 are other stages of project's engagement with the project affected persons.

6. Analysis of Alternatives

This section of the report presents the analysis of the alternatives considered for the project. The following scenarios have been considered.

- No Project Scenario (With & Without project Scenario);
- Alternate Location/ Alignments for the Proposed Project;

6.1 No Project Scenario

Kochi also known as the financial, commercial and industrial capital of the state of Kerala, is also the most densely populated city in the state. Kochi has witnessed urbanization, including commercial developments in the recent past which has added a demand on Kochi's transport infrastructure. Kochi's transport infrastructure is overwhelmed with transport demand. Private and/ or road transportation in itself will not cater to these rising demands, due to limited space restrictions on vehicular movement and parking areas. Public transport system effectively utilizes limited space by catering to a larger population at greater speeds, thus limiting time lost in commuting. Kerala government planned to augment the existing Kochi Phase I metro rail system which currently covers the following areas:

- Aluva to Maharajas' College (operational)
- Maharajas' College to Petta (under construction)

Proposed expansion from Phase I includes Petta to Tripunithura to cater to a larger population. The location caters to the traffic from both Eastern & Southern sides of Ernakulam. Tripunithura Municipality is planning to build a bus depot near to the Railway Station which will act as a catalyst to develop the area as a multimodal transport hub of railway, metro & bus transport, eventually will become the entry point to the city there by increasing the passengers per hour per direction of the entire metro corridor.

6.1.1 Environmental Impacts/ concerns:²⁴

6.1.1.1 Ambient Air quality and Climate change

In the absence of proposed project, it is likely that private vehicular use or road transportation rentals (such as taxis) will increase, leading to increased greenhouse gas (GHG) emissions. Elevated GHG emissions can lead to changes to temperature profile and rainfall pattern in the area.

Extension of the existing Kochi metro will lead to a reduction in number of private vehicles used for transportation. This in turn will lead to a reduction in 412457 Km travelled by 2021 and 632130 Km by 2031. Reduced kilometres travelled, will also reduce the fuel requirement. It is estimated that diesel requirement will be reduced by 36.027 million litres by 2021 and 56.537 million litres by 2031 and petrol requirement will reduce by 0.576 million litres by 2021 and 0.797 million litres by 2031. This will intern correspond to lower Greenhouse Gas (GHG) Emissions. Vehicular emissions including HC, NOx, Particulate Matter, CO & CO₂ are expected to reduce by 81 Tons/yr, 1947 Tons/yr, 136.5 and 2077.5 Tons/yr respectively by 2031. It is estimated that about 117051 tonnes of carbon di-oxide reduction will be achieved by 2031, amounting to 21.32 million carbon credits (certified emission reductions) earning which is equivalent to INR 42.84 million. Furthermore, air quality will improve and with fewer traffic jams, time of travelling will also be reduced.

6.1.1.2 Noise

Noise levels would increase multi-fold due to increased vehicular traffic (movement and honking) and which will be also compounded by traffic jam scenarios.

Proposed extension will add noise both in construction phase and operation phases. However, construction phase noise would be for a limited time duration and would be more localized. Rail noise,

²⁴ ALTERNATIVE ANALYSIS FOR MASS TRANSIT SYSTEM FROM PETTA TO SN JUNCTION TRIPUNITHURA

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operation of traction equipment, motors, compressors and noise due to elevated structures would contribute to noise generated during operation phase. However, this would be lower than noise contributed by vehicular traffic. Due to reduction in vehicular traffic, noise due to vehicular movement would reduce significantly.

6.1.1.3 Land Use

Without Proposed extension of Metro:

In the absence of proposed project to cater to future traffic demand, large amount of land will be required for road widening, in comparison to what is required for metro project. Additionally, the existing land use around the alignment will change considerably from current commercial/ residential.

With Proposed extension of Metro:

The alignment is passing through the median of the road and the entire corridor is elevated, therefore land requirement is minimal, in comparison to road/ highway projects. Smaller land use impacts are anticipated due to extension of metro, as compared to that of expansion of roadways.

Land is altered mainly during construction phase, which is limited to excavation (of piers or foundation). Excavated soil is reused on medians for green belt development. Additionally, metros are proposed along existing roadways for utilizing its RoW or median.

6.1.2 Social Impacts/ Concerns

Without Proposed extension of Metro:

In the absence of proposed project, there will be negative social impact due to increased traffic, land acquisition and R & R requirements (for expansion of old and construction of new highway/roads), traffic jams and corresponding time loss. There will also be increase in probability of road accidents, higher traveling costs due to private vehicles and higher fuel consumption.

With Proposed extension of Metro:

Extension of Kochi metro will have a beneficial social impact as it will provide a low cost, reliable, fast and safe public transportation system that has low transportation cost & provides less exposure to pollutants (reduction health related costs). Additionally, it reduces fuel consumption & associated GHG & exhaust emissions and offers an option with comparatively lesser land acquisition requirements. This project will be reduced traffic congestion and improved quality of life by providing a well-developed transportation infrastructure. This project will also generate employment during construction & operation phases and develop commercial activities at and near stations thus leading to development of area and generation of indirect employment.

Conclusion

Based on the above comparison, it can be concluded that in the absence of extension of Metro, roadway expansion will be required to cater to increased development in the area. This will lead to increased adverse impacts to air quality (due to increased vehicular emissions), ambient noise (due to vehicular movement and honking)and adverse social impacts. A metro extension will provide development of safe, reliable, fast & cost-effective public transportation system, reduced air & noise pollution and increased employment generation. Overall the project will result into development of public transportation system which will be integrated with the other modes like bicycle sharing system, feeder buses, city buses, railways, cycle rickshaws and auto rickshaws, overall improving the connectivity and accessibility of the site.

6.2 Alternate Locations for Project

Factors considered during selection of alignments include:

- Available RoW and land acquisition requirement,
- Forest/wildlife/plantation with alignment or AOI
- Planned Government projects,

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- Existing/ under construction road infrastructure/ flyovers / ROBs,
- Water channels,
- Abutting structures including high-rise building and Railway infrastructure,
- Land availability for stations, terminals/ depots and train operation planning.

Three alternative alignments were considered for this section. All the three alternatives are discussed below

6.2.1 Alignment 1: Petta – Tripunithura along Refinery Road:

Shortest route of 3.1 km total length, serving the population along refinery road (major commercial area).

6.2.2 Alignment 2: Tripunithura along Petta -Gandhi Square Road, canal road and Railway Line

Potential link to Tripunithura measuring about 4.23 Km total length (up to Tripunithura railway station) which will pass in vicinity of Tripunithura Bus Terminal and Tripunithura Railway Station. Since it needs to pass through canal road, it has the potential to impact eco sensitive water body especially during construction phase. Furthermore, government has already planned a bypass road along the canal which may get affected due to metro line.

6.2.3 Alignment 3: Tripunithura along Refinery Road and Proposed four lane Municipal Road to Municipal bus depot.

Tripunithura Municipality is planning to build a Bus Depot near Railway Station which will act as a catalyst to develop the area as a multimodal transport hub of railway, metro & bus transport, eventually will become the entry point to the city thereby increasing the PHPDT of the entire Metro Corridor. Also, a four-lane road is proposed by municipality for the smooth exit and entry of buses. So, a slight change in alignment from alternative-2 is proposed in this alignment. Some of the land is being acquired by municipality for construction of proposed road which will be utilized for construction of metro and thus minimizes the land acquisition requirement. Further with this alignment, Tripunithura railway station becomes closer to the proposed Tripunithura terminal station.

Conclusion

Considering the pros and cons of the proposed three alignments, alignment 3 is considered as preferred alignment. Map showing the two alternatives, i.e. 1 & 2 is given below in Figure 6-1.

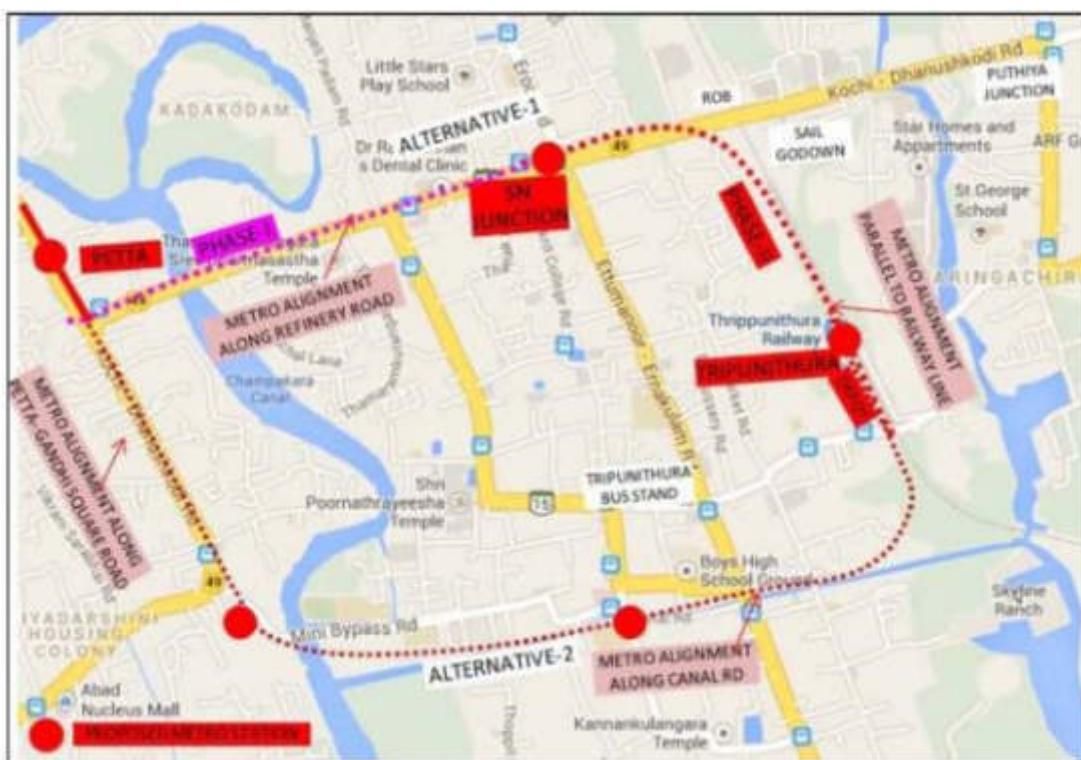


Figure 6-1: Various alternatives considered for the Alignment

6.3 Alternative System Selection and Technology

While selecting the viable transit system option, it is necessary to evaluate all of the different technological alternatives. For the proposed project the evaluation was based on basic parameters like travel demand, engineering characteristics, environmental aspects, and cost estimates.

6.3.1 Alternative mode

The different alternative modes considered for the 3.2 km long Petta – Tripunithura corridor are:

- Monorail: Monorail trains operate on grade separated dedicated corridors with sharp curves, suitable in narrow corridors as it requires minimum Right of Way. A serious disadvantage of monorails is the nature of their guideways and beams. Unlike rail systems, monorail beams cannot cross each other, and their switches are slow and take a large area. The disadvantages of monorail include lower average speeds and lower carrying capacities. Monorails also require investment much higher than LRT requires. Hence, it may conclude that a monorail is not a feasible mode for the Petta – Tripunithura corridor.
- At-grade LRT: The Petta – Tripunithura corridor has a varying RoW ranging from 7m to 10m. Any At-grade system shall require a minimum 7m of carriageway for operations; and at the station area a minimum clear carriageway of 8.5 m is required. To satisfy this minimum RoW requirement, significant land acquisition would be necessary which would considerably increase the cost of the Aluva – Petta corridor extension project. Hence this makes any At-grade transit system impractical for the extension.
- Elevated Light Rail Transit (LRT): Light Metro is essentially high-floor Light Rail provided with dedicated Right of way throughout the system. It can offer average speeds similar to metro, namely around 30 - 35km/h. Operation is usually automatic (driverless). The high-floor design allows level entry from matched platforms, to minimize station dwell time. The infrastructure may be at grade, as is usual for light rail, but where necessary it is elevated or tunnelled, to provide unimpeded access to stations. This yields the following advantages over heavy metro:
 - Axle load is lower, so structures are lighter,

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- Vehicle profiles are smaller, so structures, particularly tunnels, are smaller
 - Curves are tighter and grades are steeper, which allows greater use of less expensive guideways
 - Stations are smaller and less expensive
 - Vehicles cost less
- Elevated Metro: Metro System is a grade separated dedicated system for high peak traffic densities. It represents the highest performance transit mode with the lowest operating cost per space-km. Metro system has virtually unlimited life and exert a strong, permanent impact on mobility of population, urban form and character. The elevated metro provides the following advantages
 - Maximum speed:80-90km/h
 - Average speed 40-45km/h, depending on station spacing
 - Capacity 15 000-80 000 passengers/direction/hour
 - Minimum curve radius 100m
 - Axle load 15-16 tonnes

Conclusion

Considering the travel demand, it would be right to say that an elevated LRT system would suffice. But since the Petta – Tripunithura corridor is proposed as an extension to the existing operational Metro system elevate metro option is considered.

7. Impact Assessment

This chapter describes the environmental and social impacts identified by accessing the primary and secondary information gathered for the project. Impacts have been identified based on review of available project information and discussions with representatives of the project. Impacts anticipated during the operation phase have also been included and classified.

Additionally, this chapter evaluates the significance of each identified impact on the basis of the collective severity of its spread, duration, intensity and nature. Mitigation measures have been suggested for impacts evaluated as significant.

7.1 Impact Assessment Criteria

Identified impacts have been appraised along the criteria of spread, duration, intensity and nature. As presented in Table 7-1, each appraisal criterion is further classified based on the level or type of its spread, duration, intensity or nature, while stating the defining limit of each level or type.

Table 7-1: Impact Assessment Criteria

Criteria	Sub-Classification	Defining Limit	Remarks
Spread: Refers to area of direct influence from the impact of a particular project activity.	Local spread	Impact is restricted within the footprints of the project boundary	In case of biodiversity, the farthest directly impacted habitat or ecosystem service would be considered
	Medium Spread	Impact spreads up to 2 km around the project area	In case of biodiversity, the farthest directly impacted habitat or ecosystem service would be considered
	High spread	Impact spreads beyond 2 km from footprint boundary of the project	In case of biodiversity, the farthest directly impacted habitat or ecosystem service would be considered
Duration: Based on duration of impact and time taken by an environmental aspect to recover to its original state	Short Duration	When impact is likely to be restricted for a duration less than 2 years	In case of biodiversity, the anticipated recovery time of impacted habitats or ecosystem services would be considered
	Medium Duration	When impact extends up to five years	In case of biodiversity, the anticipated recovery time of the impacted habitats or ecosystem services would be considered
	Long Duration	When impact extends beyond five years	In case of biodiversity, the anticipated recovery time of the impacted habitats or ecosystem services would be considered
Intensity: Defines the magnitude of impact	Low intensity	When changes in the prevailing (baseline) environmental conditions does not exceed 20%	In case of biodiversity, percentage of loss or degradation of habitats and/or ecosystem services would be considered
	Moderate intensity	When changes in the prevailing (baseline) environmental conditions does not exceed 30%	In case of biodiversity, percentage of loss or degradation of habitats and/or ecosystem services would be considered
	High intensity	When changes in the prevailing (baseline) environmental conditions exceeds 30%	In case of biodiversity, percentage of loss or degradation of habitats and/or ecosystem services would be considered
Nature: Refers to whether the effect is considered beneficial or adverse	Beneficial	-	Useful to Environment and Community
	Adverse	-	Harmful to Environment and Community

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Table 7-2 presents the Impact Significance Matrix applied in order to assess the overall significance of the impacts appraised as per the Impact Assessment Criteria outlined in Table 7-1.

Table 7-2: Impact Significance Matrix

Spread	Duration	Intensity	Overall Significance	
			Adverse	Beneficial
Local	Short	Low	Insignificant	Insignificant
	Short	Medium	Minor	Minor
Local	Medium	Low		
	Medium	Medium		
Medium	Short	Low		
Local	Long	Low		
Local	Short	High	Moderate	Moderate
Local	Medium	High		
Local	Long	Medium		
Medium	Short	Medium		
Medium	Medium	Low		
Medium	Medium	Medium		
Medium	Long	Low		
Medium	Long	Medium		
High	Short	Low		
High	Short	Medium		
High	Medium	Low		
High	Medium	Medium		
High	Long	Low		
Local	Long	High	Major	Major
Medium	Short	High		
Medium	Long	High		
High	Short	High		
High	Medium	High		
High	Long	Medium		
High	Low	Low		
High	Low	High		

7.2 Impact Identification

Table 7-3 below presents the activity-impact interaction matrix for construction and operation phases of the project, based on environmental and occupational health and safety variables. Each of the impacts identified has been further discussed and corresponding mitigation measures have been proposed.

Table 7-3: Activity- Impact Interaction Matrix – Pre-Construction, Construction, & Operation Phase

Project Activities	Receptors/Resources													
	Pre-Construction and Construction Phase	Land Procurement	Change of Land use	Site Clearance, excavation and Foundation works and drilling for construction of Piers. Earth works/ landfill works.	Tree cutting	Dismantling/ Demolition activities	Sourcing and Transportation of Construction Materials and equipment	Storage and Handling of Raw Materials	Storage, Handling and disposal of excavated soil and Debris	Civil Works, Assembling and Mechanical installation of Prefabricated components near/ around work site.	Setting up and operation of the Casting Yard (Ready-Mix Concrete (RMC) Plant)	Handling and Disposal of Solid and Hazardous Wastes	Establishment and Use of Labour Camp	Operation of DG sets
Visual impacts														
Ambient Air and Noise Quality														
Ground water Quality														
Water resources														
Land Use														
Ecological Impact														
Social- Economic Impact														
Community Health and Safety														
Occupational Health and Safety Hazards														
Building Utilities														
Cultural and Historical Structures														

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Project Activities	Receptors/Resources										
	Operation Phase		Aesthetic and Visual Impacts		Ambient Air and Noise Quality		Soil Quality		Surface and Ground water Quality		
Water resources		Land Use		Traffic & Transport		Ecological Impact		Social-Economic Impact		Community Health and Safety	
Overhead electrical structures installation, Installation of signalling post and installation of electrical Sub-station											
Construction of the Ancillary facilities like Depot, Yard, Platforms, Ticketing Area, Parking area, Stabling line etc											
Maintenance of ancillary facilities such as store, yard, site office, Stations etc.											
Station Maintenance and Security											
Handling and Disposal of Waste											
Repair and Maintenance of infrastructure											

7.3 Environmental Impacts and Mitigation Measures

The overall environmental impacts that are possible during construction and operation phase are given in sections below. Being liner project, these impacts will be limited to construction area along the proposed project alignment.

7.3.1 Impacts during the Construction Phase

7.3.1.1 Ambient Air Quality

Dust emissions and gaseous emissions can adversely affect air quality and cause environmental nuisance to surrounding areas. The construction activities that will take place onsite and vehicular movement are expected to result in air emissions.

Anticipated Impacts

Air quality is one of the key factors/considerations for the Metro rail construction. The proposed Metro corridor project will have some negative impacts on the quality of air during the construction phase, which will attain significant positive impacts during the operational stages of Metro Rail due to improvement of air quality with likely shifting of passengers from private vehicles (i.e., two and four wheelers) to the Metro.

Exhaust emissions of SO₂, NOx, CO, CO₂ and PM₁₀ will be attributed predominantly to the construction of the plant, road activities such as movement of trucks and vehicles during construction works and point source emissions from the batching plant during construction phase.

During the construction phase, the air pollution levels are likely to increase in the construction areas on the account of the various activities associated with the construction, such as:

- **Suspended Particulate Matter:** SPM rise will be on the account from the heavy vehicles pressed into action and from the construction activities themselves. Dust from earth works during excavation of the ground for foundation, site preparation etc. Along with transportation of raw material required for civil work.
- **Oxides of Nitrogen and Sulphur:** The source of these pollutants primarily will be from the automobiles used in the construction processes. Emissions from movement of Heavy-duty vehicles and the operation of construction equipment and machines. Fugitive emissions from traffic congestion caused during the construction which will take place along the median of the road.
- Loading and unloading of huge quantities of raw as well as surplus and waste materials
- Air emissions other than dust arise from combustion of hydrocarbons particularly from the RMC plant and casting yard, and DG set.

Most of the emissions will be in the form of coarse and fine particulate matter that will settle down in close vicinity of construction site.

Operation of Ready-Mix concrete (RMC) plant / plants would be carried out at the FACT casting yard in East Eloor Kalamassery which is approximately 50m from residential area and St. Ann's Public School. Fine dust particles can cause the particulate matter in the air to increase leading to health concerns to the employees and can enter neighbouring premises and adversely affect amenity. Emissions from concrete mixer machinery can also be detrimental to the quality of ambient air. RMC plant and casting yard activity will emit particulate matters, NOx and SOx, affecting the air quality of nearby areas especially due to emission, discharge from low stack height.

Air quality could get impacted due to emissions from vehicle or equipment exhausts, transport of material and equipment's, emissions from DG sets, etc. As observed at the site, the DG set at areas such as proposed Vadakkekotta Station (site storage yard), Irumpanam stock yard and East Eloor Casting Yard did not have stack of adequate height.

As per the baseline data assessment, it is found that all the parameters monitored, at all locations, apart from concentration of PM₁₀ at Kalamassery were found to be well within the permissible limit.

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The air pollution during construction would be localized and around the alignment or associated facilities. These emissions will be restricted to the project area and are anticipated to be generated in medium concentration. However, it will be dispersed rapidly within the area leading to an impact of medium significance. This implies the effects to be of localized nature and temporary which indicates that any deterioration in air quality at project location is expected to be transient.

Mitigation Measures

- KMRL and contractors shall ensure the reduction and control of air emissions from construction activities by minimizing dust from material handling sources.
- KMRL and contractor should ensure that the entire alignment as well as all the associated facilities should be barricaded from all the sides and shall remain barricaded till all the construction works are over and the construction machinery and material are removed from the site.
- SPM from the vehicular emission may be effectively controlled according to the environmental standards, by engaging only the vehicles with proper 'Pollution Under Control Certificate' and proper and regular tuning of the vehicle engines.
- SPM from the demolition, excavation, and construction activities can be reduced by strict adherence to the good practices like proper enclosures to reduce the spill overs, water sprinkling of sites/roads and structures to reduce the air borne SPM content, water showers on the ground before land clearing activities at the construction sites, adequate dust covers for all tippers used for carrying the waste to the disposal site, etc.
- Construction Vehicles/machinery should be regularly serviced. Further, good practices like washing all the vehicle tires before they leave the construction sites, sprinkling of water on haul roads, dust cover over trucks during transport, off peak hour activities in construction reducing idling of delivery trucks, etc. must be adopted to minimize the problem of high level of SPM.
- Precautions with respect to air pollution control as stipulated in IS:5121 'Safety code for Piling and other Deep Foundation' should be adopted.
- By making use of the low sulphur fuels, the oxides of sulphur can be minimized and similarly by using well maintained vehicles the NOx emission also can be controlled.
- Adequate parking area should be provided for vehicle for loading & unloading so as to prevent parking on the road and causing traffic jams and congestion
- Loading and unloading of raw materials should be carried out in the most optimum way to avoid fugitive emissions.
- Stock piling and storage of construction material will be oriented after considering the predominant wind direction.
- Raw materials/debris/excavated muck should be properly stacked and stored under covered conditions at designated areas/storage yards. Debris/muck should be regularly removed from the site for regular storage/disposal
- Best practices such as halting of activity during sustained strong winds should be opted for. It shall be ensured that all stockpiles are covered, and storage areas provided with enclosures to minimize dust from open area source.
- Sufficient stack height needs to be provided to D.G. sets as per the Central Pollution Control Board (CPCB) norms.
- Speed of vehicles on the unpaved roads shall be limited to 10-15 km/hr in order to reduce fugitive dust emissions.
- Cease or phase down work if excess fugitive dust is observed, or there is any community grievance related to dust. Investigate the source of dust and ensure proper dust suppression.
- At the labour accommodations, only LPG should be provided as fuel. Burning of the wood or any other fuel or open burning of the waste should be prohibited at the site and the labour accommodation site

Significance of Impact

The impact on ambient air quality will have high intensity with local spread for a short duration which will result in an overall moderate impact without mitigation. With mitigation, after control of intensity the significance of the impact will reduce to minor owing to the short duration of construction.

Table 7-4: Impact Significance – Ambient Air Quality

Aspect	Scenario	Spread	Duration	Intensity	Overall
Ambient Air Quality	Without Mitigation	Local	Short	High	Moderate
	With Mitigation	Local	Short	Medium	Minor

7.3.1.2 Ambient Noise Quality

Anticipated Impacts

The major sources of noise pollution during construction are movement of vehicles for transportation of construction material and the construction machinery/equipment at the construction site such as grading, excavating and drilling for foundations, concrete batching, construction of ancillary structures, and operation of diesel generators, material movement and site clean-up, and construction equipment like dozer, scrapers, concrete mixers, generators, pump, rock drills etc. Apart from the construction site, noise levels could also elevate at the stock yard and casting yard, due to the RMC plant along with loading, unloading and transportation of precast, and other raw materials.

In accordance with various activities involved in the construction phase, noise levels may increase and in view of the construction phase extending to 3 years, the construction noise level has to be kept at minimum so as to avoid this becoming, a health hazard. Exposure to noise may lead to partial hearing loss, tension, fatigue, fast pulse/ respiration rates, dizziness & loss of balance, anger, and irritation & in extreme case nervousness.

Noise Modelling

AECOM has carried out noise modelling to study the simulation of the propagation of construction and operation noise levels at highly noise sensitive using the SoundPLAN. The SoundPLAN software was used to predict noise levels that will result from the construction site of the proposed metro line. This assessment is attentive on evaluating the noise contributions to the sensitive receptors from the construction equipment during implementation of the proposed project.

SoundPLAN is a modelling and presentation tool that helps optimizing the noise control measures and visualizing the effects of noise propagation throughout complex systems. This model is very useful to calculate sound pressure levels and generate noise maps. The output of this software is a graphical representation of the calculated sound pressure levels, considering reflections and diffractions of sound, and taking into account the geometry of buildings at the site and topography. The pressure level calculated or interpolated for each point within the modelling domain are shown as a grid of sound pressure, from which an animated contour map is generated showing isophones (lines of equal sound pressure).

The Industrial Noise Propagation module of SoundPLAN 8.2 consists of two main components, the emission calculation and the propagation calculation. The emission calculation is performed internally within the noise source database, where construction/operation equipment's sound power (SP)/pressure (SPL) level, sound generation height, their positions are defined. The propagation calculation is performed inside the calculation core of SoundPLAN. The performance of this module is further enhanced when used in conjunction with Wall Design to design and optimise the location and extent of noise barriers. Implemented calculation standards include BS5228-1:2009, CoRTN, CoRTN Lden, NORD 2000, FTA/FRA -HSGT:2005 and RLS-90, amongst many others. It is assumed that there will be provision of a 2-m high noise barrier in the construction site which is considered for the modelling study.

Noise during construction period has been modelled for one typical construction zone at the median of the road from S.N Junction metro station and Milma Dairy Crossing. All multi-storey buildings, mosque, temples and hospitals are situated on the adjoining area of the both existing roads are

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considered as sensitive receptors during this assessment; receptors have also been included at higher floors, where applicable. All the major roads connecting to the considered stretch of both the existing roads have also been considered. Figure 7-1 represents the 3D view of the constriction patch considered for modelling.

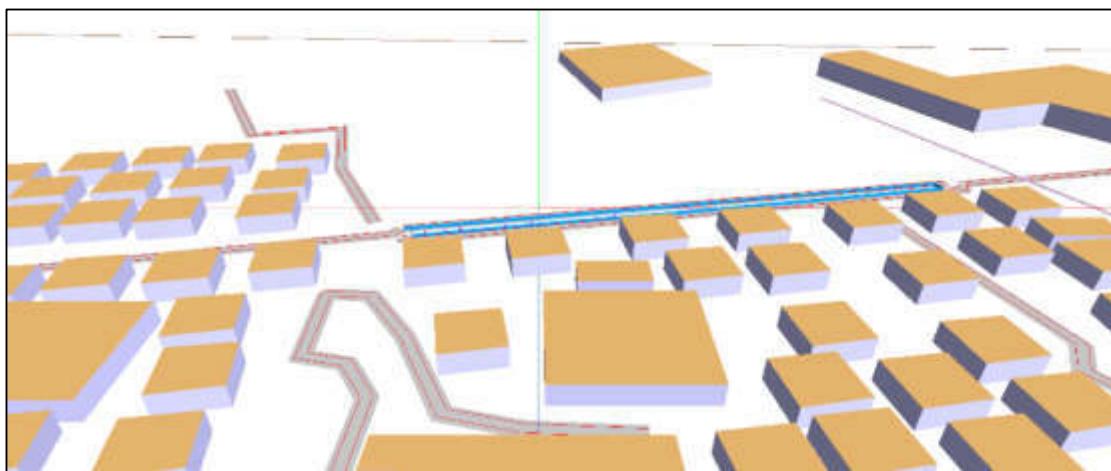


Figure 7-1: 3D view of the study area considered for the Construction Noise Modelling

Baseline noise conditions:

As per baseline study, noise levels of daytime as well as the night-time at all locations are observed to be higher than the specified CPCB standards, thus the impact on noise environment with the slight increase in noise level may be of significant to nearby residents especially during night-time. The baseline monitoring carried out by AECOM was considered as the base noise for running the model.

Assumptions

Accumulated levels of sound pressure are calculated combining the sound contribution generated during the construction phase and the conditions of existing background noise. The noise model presented in this report is considered a screening approach to evaluate potential environmental noise impacts from the proposed construction. The following assumptions were made as input in the software:

- The study area was assumed to be flat, which most closely approximates the actual topography.
- Obstacles to noise propagation, e.g., infrastructure, located near the construction site were considered.
- Vegetation cover in the calculated area were not considered.
- For the purpose of the model, the ground absorption factor (G) was determined for evaluating ground effects on sound propagation.
- The main emission sources were assumed to be point sources through machineries during construction based on their nature. Main Noise sources caused has been considered as below:

Description	Height (m)	Lw (dB(A))	No.	Type
Excavation	2	90	1	Point
Pile driving	1.5	99.5	1	Point
Front end loader	1.5	84	1	Point
Dump Truck	1	85	2	Point
Crane	1	77	1	Point
Concrete pump	1.5	84	1	Point
Truck	1	94	3	Point

- A construction barrier (barricading along the construction zone) of 2m height has been considered.

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- All noise sources were assumed to be operating continuously throughout the daytime (6-22h), including discontinuous noise sources, which corresponds to a conservative approach (higher acoustic impact).
- Stand-by units were not considered in the model as noise sources.
- Background noise considered for model run are presented in below table:

Sources	Lw (dB(A))
Traffic Noise (Day) 6-22h	60.36
Traffic Noise (Night) 22-6h	50.56
Suburban Rail Noise (Lmax) (21 trains running 6-22h and 14 trans running 22-6h)	80.7
Train Length 66.9m and speed 60k/h	

- At Vadakkekotta Station an assumption through various secondary data, thirty-three trains were considered running which have been considered to be a noise generating source and an input in the model run. These noise levels were used in combination with the predicted noise levels to be contributed from the construction equipment during construction period.

Results and Discussion:

The results of the model that were generated from a colour-coded noise level distribution grid are presented in noise contour maps Figure 7-2. The colour scale was chosen so that cool colours (green) represent low values of sound pressure and warm colours (red) represent elevated values of sound pressure. Contour lines (isophones) are representative of noise pressure intervals of 5 dB(A). The noise contour maps only represent the sound pressure level (SPLs) predicted in calculated area as a result of the construction during implementation phase. The existing background sound pressure level (SPLs) considered from existing traffic volume in major roads of that area were added to the sound pressure level (SPLs) predicted from the proposed construction site to calculate the cumulative noise levels.

The cumulative noise levels presented in noise contour maps depicts the predicted noise level during the construction phase. During the construction phase, as predicted the contribution of the noise pressure level ranges from 72-76 dB(A)L_d of the calculated area. Considering the area falling under commercial area, the predicted noise level during the day is above the CPCB Noise standard (L_{eq} Day: 65 dB(A); L_{eq} Night: 55 dB(A)).

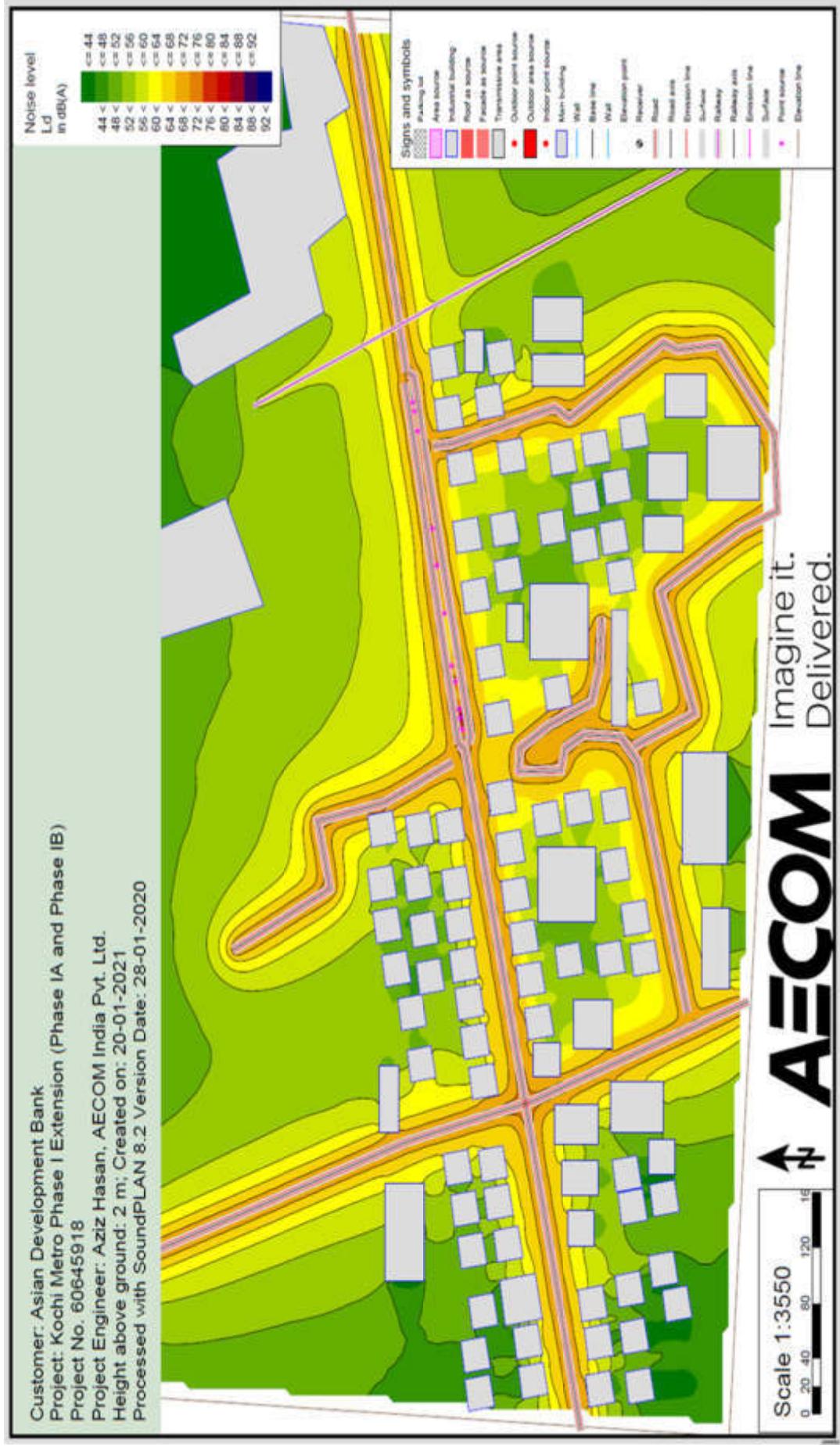


Figure 7-2: Noise Model Map during construction phase

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Construction of noise barriers, such as temporary walls between noisy activities and receivers reduces noise by up to 15 dB(A). Vegetation cover also reduces the noise level. Careful planning of machinery operation and scheduling of operations can however reduce the noise levels.

Further, as the machines used for the construction are likely to produce louder noise, it is recommended to adopt the noise reduction implements and safety protective equipment's for the workers at construction sites. The workplace safety standards shall be strictly adhered to.

In view of the size and need for early completion of the project, fast pace construction works will be carried out. Therefore, it is recommended here that the noise level on account of the operation of the various machines shall not lead to exceedance of national ambient air quality standard with respect of noise for the area.

Mitigation Measures

- Activity area should be barricaded. Steel barricades could be effective in reducing the noise by up to 15 dB(A).
- Temporary noise shields should be provided all around the heavy noise making activity especially pile driving. Noise blankets, combined sound absorbent etc. may be used to reduce the noise level in high noise generating activities like pile driving. Precautions w.r.t noise control as stipulated in IS:5121 'Safety code for Piling and other Deep Foundation' should be adopted.
- DG sets to be used as captive standby power sources with standard acoustic enclosures.
- Mobile noise sources such as cranes, earth moving equipment shall be routed in such a way that there is minimum noise disturbance to receptors.
- All the construction machinery and equipment used should be provided with adequate noise mufflers and noise suppression equipment. Proper lubrication and maintenance of the machinery & equipment and vehicle to be carried out to minimize the noise generation due to abrasion
- Construction vehicles and machinery will be well maintained and not kept idling when not in use.
- EPC Contractor shall train their safety officers to arrange for inherently quiet construction methods, equipment and machines to maintain the noise level to minimum.
- The hours of operation for specified pieces of equipment or operations, especially mobile sources operating through community areas should be limited and avoided at night
- Rubber padding/noise isolators will be used for construction equipment or machinery.
- Temporary noise barriers shall be provided surrounding the high noise generating construction equipment.
- The personnel involved in high noise generating activities shall be provided with personal protective devices (earplugs or earmuffs) to minimize their exposure to high noise levels.
- Job rotations should be practiced for workers, working in noisy environment. Workers in those sections where periodic adjustment of equipment/machinery is necessary, should be provided with sound proof control rooms, so that exposure to higher noise level is reduced.
- Honking should be prohibited at the site. For management of traffic, a traffic supervisor and marshals should be available 24 X 7.
- Periodic monitoring of noise level should be conducted and compared with the ambient noise standard.
- It should also be made sure that the levels do not exceed the national ambient air quality standard (NAAQS) level.
- OSHAS and world bank guidelines should be followed for maintaining noise exposure levels of the construction workers As per occupation standards, workers" exposure to 90 dB(A) noise level should not be more than 8 hours. OSHAS guidelines should be followed for exposure to specific noise levels for workers.
- In case of complaints of uncomfortable noise received from the inhabitants of nearby settlements possibility of putting noise barriers near to the receptor or alteration of working hours should be considered.

Significance of Impact

The impact due to noise will have High intensity with a medium spread for a short duration which will result in an overall major impact without mitigation. However, with proper implementation of suggested mitigation the impact will be reduced to moderate.

Table 7-5: Impact Significance – Ambient Noise Quality

Aspect	Scenario	Spread	Duration	Intensity	Overall
Ambient Noise Quality	Without Mitigation	Local	Short	High	Major
	With Mitigation	Medium	Short	Moderate	Moderate

7.3.1.3 Vibration

The whole alignment of the Kochi metro Phase I extension is elevated. Human response to ground-borne vibration is influenced by amplitude, duration and frequency and are subjective in nature. According to the U.S. Department of Transportation, (1998) the perception threshold of humans for particle velocity is about 0.04 mm/s (65 VdB with reference 1e-6 inch/sec). For a person in their residence, the lower threshold for annoyance is 72 VdB (FTA 2006). The safe ground vibration level for structures for low-frequency vibration is 19.05 mm/sec and 50.8 mm/sec for frequencies above 40 Hz. (United State Bureau of Mines, 656, RI 8507). The vibration affects human health by causing fatigue, increased pulse & respiration rates, dizziness & loss of balance, anger and irritation.

Due to construction of the proposed project, vibrations are expected to be created which has the potential to cause some damage to the building and properties. Major source of vibrations would be due to drilling for pier foundation construction. Controlled blasting (if required any) to remove hard rock, will generate ground vibration and noise of which intensity depends upon the quantity of explosive charge.

Mitigation Measures

- Use construction equipment manufactured or modified to dampen noise and vibration emissions, such as:
 - Use electric instead of diesel-powered equipment.
 - Use hydraulic tools instead of pneumatic impact tools.
- Maximize physical separation between vibration generators and receptors. Separation includes following measures:
 - Provide enclosures for stationary items of equipment and barriers around particularly noisy areas on site.
 - Locating stationary equipment so as to minimize noise and vibration impact on community.
- KMRL shall configure the construction site in a manner that keeps high vibration creating equipment and activities as far as possible from sensitive locations and nearby buildings.
- Grading of surfaced irregularities on construction sites to prevent the generation of impact noise and ground vibrations by passing vehicles.
- Schedule work to avoid simultaneous activities that both generate high vibration levels.
- In case of complaints received from the inhabitants of nearby settlements possibility of putting vibration dampers near to the receptor should be considered

Significance of Impact

The impact due to vibration will have medium intensity with a local spread for a short duration which will result in an overall moderate impact without mitigation. However, with proper implementation of suggested mitigation the impact will be reduced to Moderate.

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Table 7-6: Impact Significance – Vibration

Aspect	Scenario	Spread	Duration	Intensity	Overall
Ambient Noise Quality	Without Mitigation	Local	Short	Medium	Moderate
	With Mitigation	Local	Short	Low	Minor

7.3.1.4 Impact on Surface and Ground Water Quality

Anticipated Impacts

In the construction phase, water will be required for civil work during the preparation of concrete, construction of the foundation and building structure of all facilities, as well as for worker needs water for their daily use.

As per information published by Central Ground Water Board, most of the areas falling along the alignment have been categorised under the “Safe Zone” for groundwater resources. As informed by the KEC-CCECC, most of water used in the civil construction will be sourced from authorised tankers. Domestic water requirement will be only for drinking, which will be met by packaged drinking water. However, there would be abstraction of groundwater at Depot and Casting yard which houses the labour camp. Hence it would be essential to receive a No objection certificate from government department and follow the conditions provide in them.

Water Demand

Water will be required for domestic purpose of construction workers and staff and for carrying out construction activities, in batching plant for manufacturing of RMC, curing of structures, material mixing etc. Water requirement for construction purpose & at casting yards is approx. 60 KL.

500 employee/labour will be employed and accommodated at two labour accommodation camps for the proposed Kochi Metro Phase I Extension thus domestic water requirement for the labour is anticipated to be 55 KLD considering 500 persons @ 110 Lpcd per person for activities such as drinking, cooking, personal washing, washing clothes etc.

As per consultation with the site representatives, water would be sourced from authorised tanker water along with packaged drinking water at both labour camps and at the site.

Construction is expected to last for 3 years; thus, the impact on water availability is anticipated to be short term. Measures are proposed to minimize the water requirement so as to minimize the impact on water resources.

The groundwater extracted (if any) during construction works, shall have to receive a NOC from the State Groundwater Authority Water Resources Department, Government of Kerala and be appropriately used for recharging of the ground water table in the vicinity wherever possible. In addition, suitable drainage network, collecting tanks and pumping system, etc. are to be incorporated to tackle the perennial seepage to sub soil water.

Impact on Surface Water

Project alignment will pass through Chembakkara Canal along with other 3rd, and 5th order drains. Improper planning of project construction activities could lead to flow obstruction/changes in course of waterways and sedimentation. For the Phase IB, surface water drain was observed at the Tripunithura station area. As informed by KMRL and its EPC contractor, the surface water drain would be retained, and culvert would be widened to avoid the diversion of natural flowing path of water. For the proposed project the main concerns being the Chembakkara Canal and Canal at the proposed termination point of the metro at Tripunithura station.

The design at the canal should be in such a way that there is no diversion in their natural flow pathways, owing to the flood risk Kochi is prone to.

Impact on existing storm water drainage would be a key concern. Any untreated waste discharge from construction activity which get into water streams or soil erosion may also pollute local streams. Widening/ new construction of roads could result in the alteration of drainage unless proper cross

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drainage structures are provided and may also lead to waterlogging of adjacent lands. As observed at the site drainage maintenance was poor at the construction site. Wastewater accumulation could eventually lead to run off into the Chembakkara Canal causing contamination of surface water.

Alteration of soil structure during construction could lead to erosion and subsequent siltation in the surface water bodies at the downstream areas. Changes in surface hydrology can in turn adversely affect conditions that maintain healthy biological resources especially the aquatic ecology.

Runoff from site preparation activities could result in an increase in turbidity and organic load of surrounding water bodies. This will adversely affect the water quality and aquatic organisms.

Pile foundation will be carried out in the Chembakkara Canal area and elevated sections which will have concrete foundation. A pile foundation usually consists of a base of spread footing or grillage supported by piles at their bottom. Temporary canal training structures as cofferdams can be erected so that the water flow will bypass the foundation area of the bridges. These structures will be removed after completion of the construction work. This may cause temporary disturbance to flow and quality of surface water bodies. However, KMRL has received a go ahead from the irrigation department, where in KMRL have asked the department for construction of temporary bund as part of construction methodology, which will be removed once the work has been completed. Also, as good practice the construction at the centre of the canal would be carried out by floating barge/pontoon.

Waste Disposal

During the construction works, there is a possibility of contaminated runoff from the site as accidental spillage of hazardous materials, improper disposal of solid, liquid and hazardous wastes and contaminated surface runoffs from the Site. Any spillage of chemicals or disposal of waste in or near surface streams can cause water pollution issues in nearby areas.

Improper handling and storage of hazardous waste like waste oil, grease, corrugated roofing sheets, soaked cotton with oil/grease, etc. could lead to leachate which can contaminate ground water or surface water body. Other wastes include waste from paints, their cans, bitumen, etc. Contamination of river area can occur due to solid and liquid waste generated during construction activities. Untreated discharge of domestic effluent from toilets set up for workers can contaminate surface or groundwater sources.

As observed at the site locations such as storage yard at the proposed Vadakkekotta Station, and Irumpanam stock yard were not equipped with paved impervious surface or secondary containment for fuel storage. This could lead to runoff and contamination of ground and surface water.

Ready-Mix Concrete (RMC) Plant

Batching plant wastewater includes cement, sand, aggregates and petroleum products. These substances can adversely affect the environment by increasing water pH, increasing the turbidity of waterways, etc. Increased turbidity results in less light entering an aquatic environment.

Establishment and Operation of the Labour Camps

During the construction phase, two labour camp have been set up and hence generation of domestic wastewater from the labour camp and portable cabins is anticipated. Improper disposal of sewage and wastewater from worksite and construction debris can contaminate the groundwater resources.

Mitigation Measures

- KMRL needs to develop a detailed water and wastewater management plan for the project for better management of water and wastewater and it should include mapping of total water consumption at different end use (cleaning, utilities, domestic), its generation at different process and activities, its treatment, monitoring, discharge, recording, opportunity for minimization, recycling wherever possible, continue improvement in systems at different stages to minimize use and generation, training and capacity building, periodic audits and other studies, as applicable;
- Conservation of water to be undertaken at all project locations and ancillary facilities and if possible, recycling and reuse of water to be taken utilising every opportunity.

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- Effort should be made so that any further stress on the existing water distribution network system can be avoided.
- To ease the burden, as an alternative, it is suggested that, wastewater that is being treated at various sewage plants near to the proposed corridors, may be explored after carrying out suitable feasibility study for utilization for various purposes like curing, dust suppression, etc.
- Specific formats for water balance, water and wastewater inventory, etc. should be developed and records of these specific to the sites should be maintained
- Periodic monitoring shall be carried out to ensure that the wastewater is not finding its way to ground and surface water;
- Conservation of water to be undertaken at all project locations and ancillary facilities and if possible, recycling and reuse of water to be taken utilizing every opportunity;
- Site restoration plan to accommodate the loss of groundwater (if abstracted) can be undertaken.
- Workers should be educated to use water wisely and do not leave the taps open without use. Written notice should be displayed near the water taps for saving water & closing the taps.
- Low flow taps shall be provided in toilets and kitchen and all water storage tanks should be covered to minimize loss due to evaporation.
- Regular inspection of the water storage structures and pipelines to detect leakages. Detected leakages should be immediately repaired to minimize water loss.
- Proper toilets shall be provided at site and labour camps to prevent open defecation. Sewage shall be disposed from toilets, kitchen and washing area through septic tanks. Septic tank shall be cleaned on regular basis through the authorized agencies of local bodies.
- Construction of dedicated storm water drains for reduction of any contamination to runoff due to project activities. The storm water drains at RMC plant area, or other areas letting out hazardous wastewater should be provided with adequate filters and oil interceptors to avoid hazardous waste running off into any streams, soil or ground water.
- Storm water drains shall be designed considering natural topography to avoid any obstruction to natural flow and final outlet shall be connected to maintain natural flow of water.
- Drainage at FACT casting yard and store yard needs to be carried out in the periphery of the boundary. It should also be made sure that the wastewater flows to adjacent drainage of the region and not find its way to any surface water, which could lead to contamination of ground or surface water.
- Using curing agents for carrying out curing. If water is used for curing, then low flow sprinklers should be used for curing purpose, curing should be carried out during early morning & evening to minimize evaporation, concrete structures should be covered with gunny bags after curing is done to conserve the moisture.
- Run-off from curing should be collected through drains into sedimentation tank and should be re-used for curing or washing of vehicle/machinery or for wheel washing.
- Periodic monitoring shall be carried out to ensure that the wastewater is not finding its way into surface and groundwater;
- All solid and hazardous wastes such as construction debris, used or waste oil, paint cans, etc. will be stored on impervious surface with secondary containment in secure location to avoid surface and groundwater contamination;
- Paved impervious surface and secondary containment to be used for fuel storage tanks, and associated areas;
- Loading and unloading protocols should be prepared and followed for diesel oil and used oil;
- It should be made sure that oil / chemical leak response procedures are prepared and necessary equipment's to deal with oil / chemical leaks are in place.
- Ensure drip panes are provided to vehicles with leaks to prevent water contamination;

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- Ensure Leak proof holding tanks for sanitary wastewater to protect the shallow ground water level.
- No machinery washing or cleaning should be undertaken near any water body. Vehicle washing water should be collected and channelized into septic tank. Fuel storage should also be away from water body (minimum 100 m). No maintenance workshop shall be established within 100 m of any water body
- Silt fencing should be undertaken near the Chembakkara canal as well as the canal near the termination point at Tripunithura station to prevent flow of silt/debris in canal. Mitigation measures need to be strengthened to protect the Chembakkara canal from contamination.

Significance of Impact

Medium distribution of impact with high intensity and short duration will result in an overall major impact without mitigation. However, with mitigation the intensity is envisaged to reduce to moderate, resulting in an overall moderate impact.

Table 7-7 Impact Significance – Impact on Surface and Ground Water Quality

Aspect	Scenario	Spread	Duration	Intensity	Overall
Impact on Surface and Ground Water Quality	Without Mitigation	Medium	Short	High	Major
	With Mitigation	Medium	Short	Moderate	Moderate

7.3.1.5 Soil Quality

Anticipated Impacts

It is expected that a significant quantity of soil and boulders will be excavated during the construction activity along with construction and demolition waste from dismantling of structures. Problems could arise from dumping of construction spoils (concrete, bricks), waste materials, etc. at the site. A portion of this would be used for backfilling. However, a major portion of the excavated soil has to be disposed out of the site in an environmentally friendly manner. It is, therefore suggested that various locations such as abandoned quarry pits, low lying lands may be identified /selected for disposing this soil. Which later on, can be used for other useful purpose like site for afforestation/playground and for landscaping. Further, in case of low-lying areas are chosen for disposal, it is suggested to preserve the topsoil of the designated site which can be reused during reclaiming works. As part of the extension project, road widening would also be undertaken, a lot of the topsoil could be used for the construction of the road.

Removal of vegetation during the site clearance can result in erosion as bare soil is exposed to the effects of rain. Secondary effects can be associated with this, as sediments can make its way into local watercourses affecting water quality for its intended use. KMRL shall make sure careful planning, cleaning, redressing, landscaping and revegetation is carried out to preserve the strength of the soil and not speed up erosion, especially for construction near rivers sections.

Hazardous material and 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. Unsafe storage and disposal can result in soil pollution. The Hazardous waste or material such as oil, oil barrels, paint boxes, oil stained cotton, etc. if not stored on paved surfaces with adequate containment could cause contamination of soil.

Soil contamination could also occur due to lack of proper sanitation facilities (human waste disposal). This could also lead to health risks such as insect /vector borne disease. This could affect local workers and nearby local population. Following mitigation measures are recommended to reduce impact on soil due to project activities.

Mitigation Measures

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- Restricting the site clearance to those areas only where the construction activities are to start immediately, and development of vegetation cover as soon as, or even prior to, the site clearance activity is started. Use excavated soil at the time of plantation.
- Allow only covered transportation of topsoil within project site.
- Provide appropriate storage of excavated soil along with the construction and disposal in an isolated and covered area to prevent its loss during high wind and runoff.
- All the excavated material shall be properly stacked in the pile with the slope not more than 1:2 and shall be kept covered. Excess excavated soil shall be removed from the site on regular basis
- Formation of soil banks can be avoided so that the sediments do not enter into water bodies affecting the intended use and/or drainage system which can result in chocking of the whole system including collection and treatment system. Silt arresters shall be provided along the canal in this activity area to prevent flow of silt in canal.
- Fuel, used oil, paints and loose construction material shall be stored on paved surface in covered condition only to prevent its spillage. Proper drainage shall be provided around the fuel/used oil/paint storage area so as any spillage can be collected. These drains shall be provided with oil & grease trap also to prevent mixing of oil with the site run-off
- Disposal of waste should be carried out as per the various waste management rules under the Environmental Protection Act.
- Any hazardous waste like used oil from DG sets/machinery shall be disposed off through authorized hazardous waste vendors
- Include proper water supply, sanitation, drainage and human waste disposal facilities.
- Re-vegetation to be done in the area after the completion of construction, in order to reduce the risk of soil erosion.
- Areas to be used temporarily shall for establishing casting yards, workshops, storage, labour camps shall be restored back to the original conditions

Significance of Impact

Considering the distribution of impact within the project boundary and short duration of construction phase with moderate intensity makes impact of moderate significance and can be controlled with the recommended mitigation measures.

Table 7-8: Impact Significance – Soil Quality

Aspect	Scenario	Spread	Duration	Intensity	Overall
Soil Quality	Without Mitigation	Local	Short	Medium	Moderate
	With Mitigation	Local	Short	Low	Minor

7.3.1.6 Muck

Excavation will be undertaken only for construction of piers and foundation of the entry/exit structures. Muck to be generated due to excavation (assuming 110 piers, excavation depth 8.5 m; width 2 m; and length 2 m and 7 nos of entry exits for 3 stations having width 5 m, length 10 m and depth 3 m) will be approx.4800 cum out of which 120 cum is top soil (15 cm depth). Before excavation, the contractor will be required to test the soil quality including heavy metals and the results will be compared with standards.

For pier construction, polymers are used for stabilisation of bore, hence the muck extracted is stained with polymers. From qualitative point of view, good quality muck can be reused as aggregates for construction and backfilling. low can be used for land reclamation or as refilling material.

This muck if disposed in improper unscientific manner may impact the soil quality, air quality and water quality of the area significantly. If the soil is contaminated, disposal will be done with due treatment or isolation of such muck.

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As observed the waste management plan does not include the muck disposal. There was no plan observed for Polymer mixed muck disposal by KMRL or its contractor. There was no trail established of the final disposal of this Polymer mixed mud waste. Following measures are proposed to minimize the impact due to disposal of muck

Mitigation Measures

- KMRL in coordination with the contractor shall prepared a muck disposal plan.
- Disposal sites must be identified by KMRL or its contractors, such that pollution of water bodies and green areas are not impacted, and displacement of persons is not involved.
- Material will be stock piled with suitable slopes
- Material will be stabilised each day by watering or other accepted dust suppression techniques. The muck shall be filled in the site in layers and compacted mechanically.
- Options shall be used for exploring usage of excavated muck for the road widening and construction purpose or for construction purpose of metro or other construction happening nearby.
- Contractor could also identify the location for establishment of the debris disposal site. This debris disposal site shall preferably be established on the waste land.
- Debris disposal site shall not be constructed in the forest area, agriculture field and settlement area and minimum distance of approx. 500 m shall be maintained from water body, settlement area, forest/wildlife area
- Debris collection site shall be covered through wall on all the sides and proper drainage channels shall be provided at the site to channelize the run-off.
- This site shall be used for disposal of excess excavated muck and the remaining construction waste which is non-hazardous in nature
- Site shall be properly compacted after disposal of muck and topsoil cover of 15 cm shall be provided after compaction. This site shall be stabilized by carrying out the turfing and tree plantation on the site
- Once the filling is complete, the entire muck disposal area shall be provided with a layer of good earth on the top and covered with vegetation.

Significance of Impact

The impact due to Muck disposal will have Medium intensity with a medium spread for a short duration which will result in an overall Moderate impact without mitigation. However, with proper implementation of suggested mitigation the impact will be reduced to Minor.

Table 7-9: Impact Significance – Muck Disposal

Aspect	Scenario	Spread	Duration	Intensity	Overall
Ambient Noise Quality	Without Mitigation	Medium	Short	Medium	Moderate
	With Mitigation	Medium	Short	Low	Minor

7.3.1.7 Solid and Hazardous Waste Management***Anticipated Impacts***

The construction activities such as site clearance, excavation works, and civil work will generate different types of solid and hazardous wastes. This type of construction waste has to be disposed off, at the appropriate disposal/land fill sites as per the guidelines/procedure stipulated by various regulations. It is required that for this purpose, necessary permission/applicable guidelines regarding the disposal sites may be obtained with the consultation of the municipal authorities of Kerala(if required). Improper disposal of packaging materials, boxes, plastics, ropes etc. can lead to littering in the construction site and surrounding areas.

The following types of wastes will be generated due to construction of the project:

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- **Domestic solid waste and sewage from labour accommodations:** Wastewater Generated at Labour Camp would be approximately 44 KLD of domestic sewage from 500 workers. Septic tanks and soak pits have been provided at labour camps. Sewage is connected to sewer line after septic tank. Improper disposal of solid waste from the labour camps and lack of proper sanitation facility for labour can lead to unhygienic conditions due to open defecation and spread of diseases in the area. It can also lead to discontent of local community and result in conflicts with the labour engaged at site. The EPC Contractor shall ensure that the labour camp has adequate waste disposal facilities. Arrangements for collection of garbage in coloured segregated dustbins as per the solid waste management rules and daily disposal to the nearest dumpsite shall be made.
- **Used oil, oil lined containers, oil-soaked rags from generator and other construction machinery:** Hazardous wastes such as used oil from DG sets, lubricants, hydraulic oil, etc. can cause contamination of soil and water bodies if adequate precautions for storage, management and handling are not undertaken. Use of chemicals such as paints, curing chemicals can lead to contamination of soil, ground water and surface water bodies.
- Packaging waste such as gunny bags, plastics, etc:
- Empty paint containers, metal scrap, chemical lined containers etc.
- Excavated soil while piers construction
- **Construction debris:** The construction debris generated due to the construction activities will have the potential for spread to areas outside the project boundary during construction phase. The dust particles from debris generated during construction activities can be carried along with the wind into nearby areas, thereby increasing the particulate matter in the area along with increased turbidity in surface waters nearby. However, this will happen only for a temporary period as the construction activities will be for small duration only.

Mitigation Measures

- KMRL shall ensure that the workplace is free of trash, debris, weeds, rodents, flees, pests etc. All packaging material should be collected at the storage area and sold to authorized scrap dealers.
- KMRL shall ensure that the domestic waste generated daily from the labour accommodations are collected, stored and disposed off according to the Solid Waste Management Rules, 2016. Adequate waste disposal facilities should be arranged for segregation and collection of solid waste in different dustbins as per the Solid Waste Management (SWM) Rule 2016.
- It is necessary to keep the site and its environs in a clean condition and good standard of housekeeping. The public nuisance shall be minimized/ avoided by observing good housekeeping and control at site by avoiding open pits, slush, and materials of construction coming in the way of road users.
- Washing and bathing areas should be provided with proper drainage system so that wastewater is not accumulated in the project site. Disposal of sewage shall be made through a septic tank – soak pit arrangement.
- Waste/used oil generated from generators and construction machinery and equipment, oil lined containers, oil-soaked rags etc. should be stored on paved surface in a secure location at the project site. Appropriate secondary containment capable of containing 110 percent of the content of the largest storage tank should be provided.
- The used oil and oil lined containers, which are characterized as hazardous wastes according to *the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016*, should be sold to Kerala Pollution Control Board (MPCB) approved vendors.
- Hazardous waste should not be stored for more than 90 days as per the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016.
- Storage of oil/chemicals shall be undertaken on paved impervious surface and secondary containment shall be provided for fuel storage tanks.

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- Construction debris and excavated material to be stored in a confined area to prevent spread by wind or water. The construction debris to be used for backfilling of excavated areas and for foundation works at site.
- Recyclables viz. paper, plastic, glass, scrap metal waste etc. will be properly segregated and stored in designated waste bins/containers and periodically sold to local recyclers. Any recyclable waste should be encouraged to be recycled at the site.
- Washing and bathing areas should be provided with proper drainage system so that wastewater is not accumulated in the camp site. Disposal of sewage shall be made through a septic tank – soak pit arrangement.
- Packaging material should also be collected at the storage area and sold to authorized scrap dealers. Recyclables viz. paper, plastic, glass, scrap metal waste etc. will be properly segregated and stored in designated waste bins/containers and periodically sold to local recyclers. Any recyclable waste should be encouraged to be recycled at the site.
- Construction debris and excavated material to be stored in a confined area to prevent spread by wind or water. The construction debris of excavated areas to be used for backfilling embankments, filling pits, for foundation works, construction of crossroads, approach roads and landscaping.
- During the site clearance and disposal of debris, the contractor shall ensure that there are no dwellings affected by the dumping of debris and other solid waste and the traffic is not interrupted.
- Debris disposal sites shall be sited away from sensitive locations like settlements, water body, forest areas and any other sensitive locations. The debris dumpsites have to be suitably rehabilitated by planting local species of shrubs and other plants so that the landscape is coherent with the local environment.
- The Contractor shall ensure that the entire existing canal and drains within and adjacent to the site are kept safe and free from any debris or any hazardous waste.
- Care should always be taken to maintain the hydrological flow in the area and dumping sites do not contaminate the water sources.
- The sewage generated from the construction workers camps shall be properly designed, treated and disposed off so that no water pollution takes place.
- Treated water shall be stored properly for subsequent use for gardening and non-domestic purposes.
- Biodegradable domestic waste generated from the construction workers camps shall be stored properly and treated either by composting or by land filling or handing it to local municipal waste disposal agency.

Significance of Impact

The impact due to waste disposal will have High intensity with a local spread for a short duration which will result in an overall Moderate impact without mitigation. However, with proper implementation of suggested mitigation measures the overall impact will be minor.

Table 7-10: Impact Significance – Waste Storage and Disposal

Aspect	Scenario	Spread	Duration	Intensity	Overall
Waste Storage and Disposal	Without Mitigation	Local	Short	High	Moderate
	With Mitigation	Local	Short	Moderate	Minor

7.3.1.8 Occupational Health and Safety***Anticipated Impacts***

Occupational Health and Safety (OHS) of workers is important during construction phases where local and migrant workers are involved. The activities included in the construction phase that have potential

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impact to OHS of workers are land clearance for establishment of temporary structures, batching plant, mobilisation of equipment, drilling for pier construction and other civil work.

Construction activities involve risks to health & safety of construction workers as it involves handling of heavy construction machinery/vehicle/components & lifting equipment, work at height, etc. Occupational risks involved during construction phase are fall, slip, accidents, failure of crane, fire, electric shock etc. The following occupational health and safety risks are frequently present, in particular during the construction phase:

- Mobile vehicles and heavy equipment accidents;
- Heat stress when working in high temperatures;
- Manual handling and musculoskeletal disorders;
- Vibration impacts from concrete breakers, grinders, hammer drills, chipping hammers, chainsaws, scrabbles and needle guns;
- Temporary or permanent hearing loss from noise generated machinery used for excavation or piling work;
- Dermatitis that can rise from contact with small substances such as wet cement and asphalt;
- Tripping due to uneven surfaces and obstacles;
- Falling during working at height;
- Fire due to hot works, smoking and failure in electrical installations; and
- Electrical shocks etc.

Health risks include accidents due to improper construction practice and hazard diseases due to lack of sanitation facilities (i.e., water supply and human waste disposal). Implementation of good construction practice may reduce the chance of accident at workplace.

Impacts anticipated during construction phase on occupational health and safety and community health, safety & security are short term and are restricted to the construction stage only.

Mitigation Measures

Appropriate OHS programme and procedures are also expected to be in place to align with the local regulations. The procedure will include at minimum, the following measures:

- KMRL has framed the SHE policy and based on it contractor agreement has been formed, it is essential for all contractors and sub-contractors to follow the contract agreement. The contractor agreement has represented KMRL's SHE policy and addresses safety issues and mitigation measures to be taken during construction for workers as well as the safety of the nearby community
- Develop and implement a Health and Safety (H&S) plan to follow throughout the construction phase; This should include management plans for proper water supply, sanitation, drainage, health care and human waste disposal facilities at construction site. In addition to these, efforts need to be made to avoid water spills, adopting disease control measures, awareness programmes etc
- Periodic inspection of safety procedures and its implementation at the site should be carried out by KMRL as well as the EPC contractor.
- Provide occupation health and safety orientation training to all employees and workers consisting of basic hazard awareness, site-specific hazards, safe working practices, and emergency procedures; The contractors will provide training, awareness and supervision to ensure all of its construction workers comply with the OHS procedures;
- The contractors will be committed to ensure all Health and Safety measures are in place to prevent accidents and reduce the consequences of non-conformance events;
- An emergency response procedure and infrastructure will be available on Site to ensure provision of first aid for personnel in case of emergency.

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- All construction site, activity area, casting yards, fuel storage area, workshop area etc. should be barricaded and the entry should be restricted to authorized personnel only. ID cards should be issued to all the authorized personnel including the workers, labour, employee, staff, inspectors & visitors
- Transportation vehicle should be in good conditions and should comply with all safety conditions. Transportation vehicle should carry the load according to its capacity
- All the lifting equipment should be properly examined and tested prior usage. All relevant information should be known about the load, method of slinging and attachment points
- Person involved for lifting and installation works and those working in heights should be properly trained for the work assigned
- Safety officers & supervisors should be present all the time at site during execution of the work, laying of foundations, piers, piers cap, slabs etc.
- Where possible, exclusion zones should be established and maintained in order to prevent any unauthorized access to lifting areas
- When lifting large loads, ensure weather conditions are favourable for the task. Heavy lifting equipment typically has safe operating parameters included in its operating manual and these parameters should not be exceeded at any time
- All the workers should provide personal protective equipment (PPE) like safety jacket, helmet, gloves, goggles, earmuffs, safety belts/harness etc. It should be mandatory for all the workers to wear the PPEs.
- Labour accommodation should be provided with all the basic facilities like proper bedding, proper sanitation facility (toilets, bathroom & washing area), clean kitchen area, potable drinking water, waste & sewage management facility, LPG fuel for cooking.
- Gas cylinders should be kept up right on a custom build stand or trolley. Metal cap should be kept in place to protect the valve when the cylinder is not connected for use. All gas cylinders should be fixed with pressure regulator and dial gauges. Non-return valve and flashback arresters shall be fixed at both end of cylinder and torch.
- Rest area should be provided for the workers at site and workers should not be allowed to rest or lay down on the floor/machine or any other area at the construction site
- Firefighting facility should be available at the site. CO2 based fire extinguishers should be provided at the gas cutting/welding area and foam based should be provided at fuel storage area. Fire extinguishers should be provided at all areas as per suitability defined in IS: 2190. Fire evacuation plan should be provided at each work area. Fire evacuation plan should be explained to all the workers, staff & visitors. Fire exit signs should be provided at all the areas and these signs should be LED lit.
- Labour should be given PEP talks on daily basis, training for handling heavy machinery & equipment, for working on heights, handling the construction material, training on general safety etc. on monthly basis. Further mock drills should be arranged for workers for firefighting, earthquake, rescue a person for a person stuck at height etc.
- First aid trained personnel should be available at the site and tie ups with the nearby hospital should be made so as emergency situation can be handled. Ambulance or safety motorized vehicle should be available at the site 24 X 7.
- Emergency assembly area should be provided at the site and the location should be communicated to all. All worker should collect at that location during the emergency
- Emergency contact nos. (SHE head, SHE officers, Traffic managers, First Aid Personnel, Ambulance, Fire Brigade, Hospital) should be displayed at the site
- Safety guidelines, safety policy, safety slogans should be displayed at the site in English and local language of the area

Heat related Stress

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- As the construction work will be stretched out in months of extreme summer heat, heat-related illness can have significant impact on health of the workers engaged at the site. Heat-related illness is a spectrum of disorders due to environmental exposure to heat. It includes conditions such as heat cramps, fainting, convulsion, heat fatigue, rashes, and heat exhaustion as well as the more severe condition known as heat stroke.
- The heat stress can be due to many factors such as air temperature, humidity, radiant heat, wind speed, workload, physical fitness of the worker, hydration status of the workers and clothing (including PPE that may restrict air flow across the skin and hinder evaporation of sweat).
- Additionally, Ultraviolet (UV) radiation burns occurs when the skin is exposed to UV radiation from been out in the sun or from activities such as welding. The symptoms include reddening and inflammation of the skin and blistering and peeling of the skin in severe cases.

Mitigation Measures

- Increase air velocity for indoor workers by using natural cross-ventilation from windows and doors or mobile or ceiling fans. These increases both evaporation of sweat and convective heat loss and may significantly improve thermal comfort at air temperatures.
- Operate effective general and local exhaust ventilation and air conditioning;
- Avoid non-essential sources of hot ventilation (e.g. air conditioner outlets adjacent to working areas);
- Install a shield between employees and a source of radiant heat such as curtains on windows or other insulating barrier, enclose the heat source, or move the heat source away from employees;
- Provide cooled drinking water as close as possible to the work site;
- Arrange shade for outdoor workers where practicable;
- Provide a cool rest area in which workers can take their meal breaks and tea breaks;
- Modify the work schedule or shift times so that outdoor and physiologically demanding work is done in the early morning or late afternoon, when it is generally cooler, and the sun's radiation is less intense than during the middle of the day;
- Allow workers to self-regulate their pace of work. This may involve working continuously at less than full capacity, and/ or working for short periods followed by rest pauses in a cool area;
- Workers should be encouraged to present to work in a well hydrated state, and take frequent small drinks throughout each shift to replace fluid lost through sweating;
- Diuretic Fluids such as tea, coffee, alcohol and some soft drinks should not be used to replenish fluid lost due to heat;
- Use PPE that reduces exposure to ultraviolet radiation and heat (such as reflective masks or aprons, large brimmed hat, sunscreen); and
- Workers returning from periods away from hot environments should be given the opportunity to acclimatise before being expected to undertake work in very hot conditions at full capacity.

Significance of Impact

The health and safety impacts will have high intensity with a local spread for a short duration which will result in an overall moderate impact without mitigation. However, with proper implementation of suggested mitigation, the intensity can be reduced to minor.

Table 7-11: Impact Significance – Impact to Occupational Health and Safety of Workers

Aspect	Scenario	Spread	Duration	Intensity	Overall
Impact to Occupational Health and Safety of Workers	Without Mitigation	Local	Short	High	Moderate
	With Mitigation	Local	Short	Moderate	Minor

7.3.1.9 Impact due to Labour Camp

About 500 persons are likely to work during peak construction activity. The unskilled workers associated with fabrication work and other associated work like earthwork and concreting are supposed to stay at labour camp. Two Labour camps have been set up at Kalamassery (FACT Casting Yard) and Irumpanam Storage Yard.

There could be various impacts which may happen due to the labour camp establishment. These impacts will include temporary change in land use due to establishment of the labour camp; vegetation removal and tree cutting; generation of municipal waste and disposal on land and water; generation of sewage; increase in crime in the area; and generation of unhygienic condition due to open defecation and improper disposal of sewage and pollution of river and ground water. However, Kalamassery FACT casting yard was set up and used during the construction of Kochi Metro phase I and would be continued with 2.5ha of land. Hence, the clearing of land was not required for this labour camp.

Construction workers are more prone to infectious diseases like HIV/AIDS due to migration and lack of education. The three main transmission routes of HIV are sexual contact, exposure to infected body fluids or tissues and from mother to foetus or child during prenatal period. Training and awareness programme will be conducted during construction to avoid the spread of infected diseases and maintain good sanitation in labour camp.

Mitigation Measures

- Labour camps should be avoided to be set up on established in residential areas, agriculture land, forest area and vegetated or planted area. Waste land or open area shall be preferred for establishment of such camps
- Camps shall be established at minimum distance of 500 m from residential areas, sensitive zones (educational, religious and health centres), forest areas, wildlife areas and water bodies
- Basic facility like bedding, toilets with running water facility, cooking area and LPG fuel, bathing area, washing area, proper ventilation and proper illumination should be provided in the camps
- Dustbins should be provided for waste collection and the waste should be disposed off through the local bodies
- Only LPG should be provided as fuel. Burning of the wood or any other fuel or open burning of the waste should be prohibited at the site and the labour accommodation site
- Labour should be trained about not practicing any unfair practices and get involved in any crime like theft/drinking alcohol etc.
- Workers should be trained on hygiene, cleanliness, waste disposal and control of infectious diseases.
- In view of COVID 19 related pandemic, workers should be provided regular training and awareness on precautions to be taken. Testing should be conducted of fresh workers along with existing workers at periodic intervals.
- Personal protective equipment's (PPEs) like face mask / shield and if required hand gloves should be provided to workers. Client and contractors should ensure that such PPEs are effectively used by workers.
- Regular temperature check and record keeping of the same should be carried out for all workers and employees.
- Separate colour coded dust bin should be provided for disposal of used face mask and other COVID 19 related PPEs. These should be disposed of as per Central and State government and MPCB guidelines.
- Pre employment health check-up should be carried out and all such records should be maintained.

Significance of Impact

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The impact due to Labour camp will have High intensity with a Medium spread for a short duration which will result in an overall Moderate impact without mitigation. However, with proper measures the intensity of impact can be reduced to low resulting in an overall minor impact.

Table 7-12: Impact Significance

Aspect	Scenario	Spread	Duration	Intensity	Overall
Impact Due to labour Camp	Without Mitigation	Local	Short	High	Moderate
	With Mitigation	Local	Short	Low	Minor

7.3.2 Impacts during Operation Phase**7.3.2.1 Air Environment**

When in operation Metro systems are expected not to have any negative impact on air quality. Metro systems are planned to reduce the share of private vehicle on road and enhance the usage of public transport so as to decongest the road. The major impact after the introduction of the metro along any corridor is the significant reduction in terms of vehicular emission loads due to the shifting of personalized mode of transportation (viz., two wheelers and four wheelers) to the metro. Reduction of vehicles will lead to reduction of vehicular exhaust which is released due to plying of vehicles and due to idling of vehicles in traffic jams. Reduction in traffic on Ernakulam roads due to proposed metro rail could lead to reduced air pollution.

According to the DPR, on implementation of the project, reduction in fuel (diesel and petrol) is estimated to be about 62.816 million litres of diesel and 0.712 million litres of petrol will be saved in year 2021. These reductions will increase to 90.957 million litres of diesel and 1.303 million litres of petrol in year 2031. Net saving on fuel expenditure at current price level is estimated to be of Rs 3992 million in year 2021 and Rs 5801 million in year 2031. Some measures shall be incorporated in design are proposed which shall be taken to prevent any impact on air quality.

Mitigation Measures

- Sufficient parking space should be available at all the stations so as people can leave their private vehicle and travel in metro. Further parking of private vehicle should not lead to congestion on roads.
- Sufficient number of exit & entry should be provided at each station to minimize congestion.
- Rumble strips should be provided on the roads in front of stations so as the speed of vehicle is regulated near station area and chances of accident is minimized
- Adequate feeder services should be provided so as to maximize the catchment area of proposed metro system and minimize the usage of private vehicle to reach the station. If possible, these feeder services to be run of renewable energy to further reduce vehicular emission.
- These feeder buses should be integrated and linked to city bus services and other para-transit systems like auto rickshaws.
- Roads in the station area should be properly maintained

Significance of Impact

The impact on ambient air quality will mostly be positive have Medium intensity with medium spread for a long duration which will result in an overall moderate impact without mitigation. With mitigation, the significance will improve.

Table 7-13: Impact Significance – Ambient Air Quality

Aspect	Scenario	Spread	Duration	Intensity	Overall
Ambient Air Quality	Without Mitigation	Medium	Long	Medium	Moderate
	With Mitigation	Medium	Long	Medium	Moderate

7.3.2.2 Noise and Vibration Impacts

During the operation phase the main source of noise will be from running of metro trains. Noise radiated from train operations and track structures generally constitute the major noise sources. The main sources of noise from the operation of trains include engine noise, cooling fan noise, wheel-rail interaction, electric generator and miscellaneous noise like from passengers. The main source of noise from depot is during operation of workshop. The vibration of concrete structures also radiates noise.

The design aspects of the proposed project should consider various plans to restrict the noise propagation outside the track area. Special physical barriers of noise shall be used wherever the track is in proximity to residential and sensitive areas like hospitals and schools etc.

The quality of the track and the rolling stock is very important in controlling induced vibrations in the nearby structures. Both the wheel and the rail should be free from surface wear/ irregularities (corrugation/ flat etc.) and the defective units of the rolling stock should be removed from the operation.

US data shows that the noise levels inside the rail transit cars ranges between 65 to 105 dB(A) during normal operation but it will depend on various factors like train speed, type of way structure, sound insulations of car body, type & design of mechanical equipment, wheel and rail conditions.

Wherever excess noise is expected like elevated tracks, annular air gaps of 100 mm to 200 mm and neoprene beadings can be considered.

50% reduction of the traffic volume may result in a 3-dB reduction in noise levels, regardless of the absolute number of vehicles.

Noise Modelling

AECOM has carried out noise modelling to study the simulation of the propagation of construction and operation noise levels at highly noise sensitive using the SoundPLAN. The SoundPLAN software was used to predict noise levels that will result from the operation of the metro trains long the proposed metro corridor. This assessment is attentive on evaluating the noise contributions to the sensitive receptors from running of the metro during operation of the proposed project.

The study area considered for the noise model consists of a calculation area of 8.6 sq. km, which is both sides of the proposed metro corridor, the study area has been illustrated in Figure 7-3. Figure 7-4 illustrates the operation study area (i.e. the proposed metro corridor).

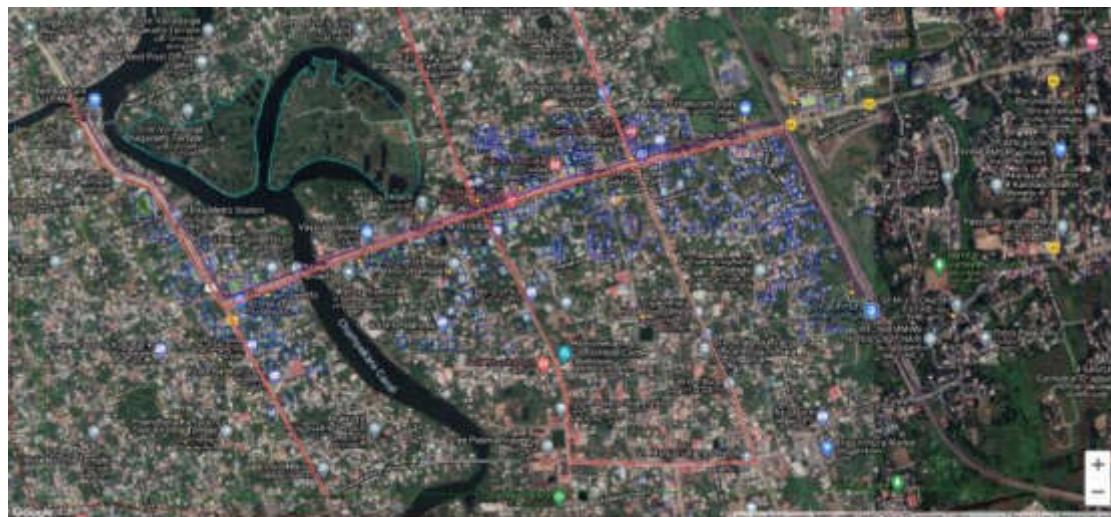


Figure 7-3: Study area for Noise modelling Study

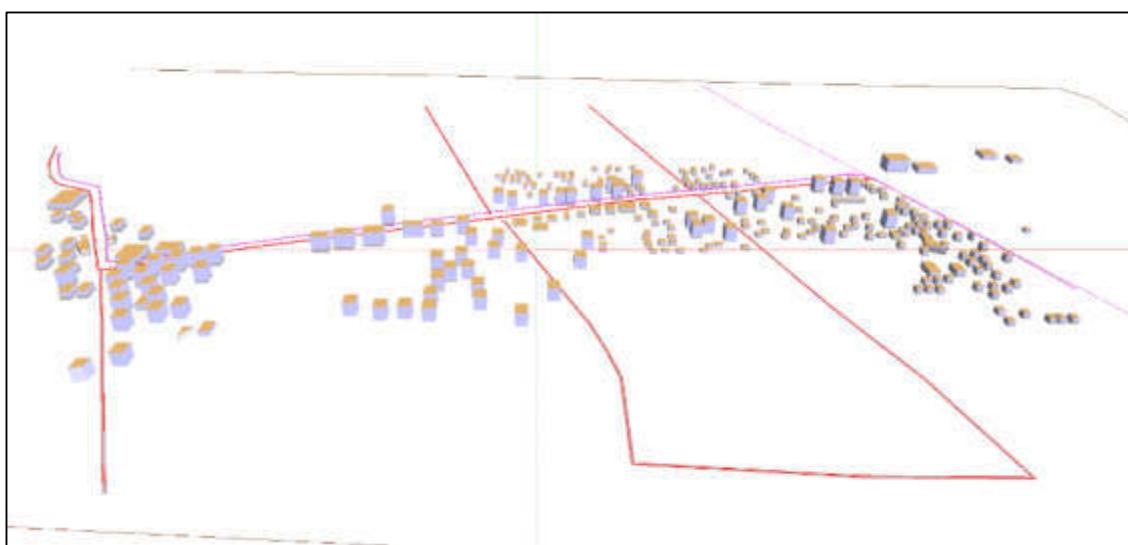


Figure 7-4: 3D view of the study area considered for the Noise Modelling

Assumptions

For operation phase, accumulated levels of sound pressure are calculated combining the sound contribution generated from the metro trains during the operation phase and the conditions of existing background noise e.g. traffic noise and suburban rail noise. The noise model presented in this report is considered a screening approach to evaluate potential environmental noise impacts from the proposed operation. The following assumptions were made as input in the software:

- The study area was assumed to be flat, which most closely approximates the actual topography.
- Obstacles to noise propagation, e.g., infrastructure, located near the construction site were considered.
- Vegetation cover in the calculated area were not considered.
- For the purpose of the model, the ground absorption factor (G) was determined for evaluating ground effects on sound propagation.
- Main Noise source considered for this model run is running of the metro rolling stock. The details of the metro train are as follow:
 - Train Length 66.9 m
 - Metro corridor above 12.5 m from ground elevation
 - Length of the metro corridor 3.2m
 - Scheduled speed 34kmph
 - Running of services for 19 hours of a day (5 AM to Midnight)
 - The main emission source (Metro Train) to be mobile sources
 - Sound pressure level during metro running –78 dBA
 - This noise assumption is predicted for the year 2025
 - Number of Trains per day each direction – 216 in year 2025
- Calculation for noise pressure levels were carried out at grade.
- Background noise considered for model run are presented in below table:

Source	Lw (dB(A))
Traffic Noise (Day) 6-22h	60.36
Traffic Noise (Night) 22-6h	50.56
Suburban Rail Noise (Lmax) (21 trains running 6-22h and 14 trans running 22-6h)	80.7

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Source	Lw (dB(A))
Train Length 66.9m and speed 60k/h	

- At Vadakkekotta Station an assumption (through various secondary data), thirty-three trains were considered running which have been considered to be a noise generating source and an input in the model run. These noise levels were used in combination with noise from metro train running during operation phase were considered on the model to determine the expected cumulative noise levels.

The results of the model run for operation phase are presented in noise contour maps (Figure 7-5) that were generated from a colour-coded noise level distribution grid. The colour scale was chosen so that cool colours (green) represent low values of sound pressure and warm colours (red) represent elevated values of sound pressure. Contour lines (isophones) are representative of noise pressure intervals of 5 dB(A). The noise contour maps only represent the sound pressure level predicted in calculated area as a result of the operation phase. For this reason, the existing background sound pressure level considered as the noise from existing 24hours traffic volume in major roads and suburban rail noise of that area and that were added to the sound pressure level predicted from the operation of metro rolling stocks to calculate the cumulative noise levels. Sensitive receptor wise noise level predicted during operation phase (in the year 2025) is presented in Table 7-14.

Table 7-14: Noise level in sensitive receptor

Receiver	Zone	Corresponding Baseline Noise level		NAAQS		Daytime (L _{dn}) dB (A)	Night-time dB(A) (Leq)	Night-time dB(A) (Leq)	L _{max} dB(A)	Leq dB(A)
		Daytime (Leq) dB (A)	Night-time dBA (Leq)	Daytime (Leq) dB (A)	Night-time dBA (Leq)					
Sree Dharmasastha Hindu Temple	Silence Zone	74.9	74.5	50.0	40.0	54	44	57.5	53.7	
Shiva Temple	Silence Zone	71.8	71.7	50.0	40.0	54.6	43.7	46.3	54.2	
Tripunitura Metro Station	Residential	69.6	69.7	55.0	45.0	55.8	51.5	75.3	55.8	
Royal Garden Residential Complex	Residential	67.7	60.2	55.0	45.0	61.8	51.2	62.3	61.4	
Residential Complex	Residential	67.7	60.2	55.0	45.0	61.7	51.4	66.5	61.7	
Royal Garden Residential Complex	Residential	67.7	60.2	55.0	45.0	62.3	51.8	63.2	61.9	
Residential Complex	Residential	67.7	60.2	55.0	45.0	62.1	51.9	67.1	62.1	
Temple Adampilli Kaavu	Silence Zone	74.9	74.5	50.0	40.0	62.1	54.4	75.7	60.9	
Residential Complex	Residential	67.7	60.2	55.0	45.0	62.4	52.3	67.6	62.4	
Royal Garden Residential Complex	Residential	67.7	60.2	55.0	45.0	62.8	52.5	64.1	62.4	
Residential Complex	Residential	67.7	60.2	55.0	45.0	62.8	52.7	68.2	62.7	
Royal Garden Residential Complex	Residential	67.7	60.2	55.0	45.0	63	52.8	62.8	62.5	
Royal Garden Residential Complex	Residential	67.7	60.2	55.0	45.0	63.1	52.8	63.3	62.6	
Royal Garden Residential Complex	Residential	67.7	60.2	55.0	45.0	63.1	52.9	62.8	62.6	
Royal Garden Residential Complex	Residential	67.7	60.2	55.0	45.0	63.2	53	62.5	62.6	
Residential Complex	Residential	67.7	60.2	55.0	45.0	63.1	53	68.7	63.1	
Royal Garden Residential Complex	Residential	67.7	60.2	55.0	45.0	63.4	53.1	62.5	62.8	
Royal Garden Residential Complex	Residential	67.7	60.2	55.0	45.0	63.5	53.2	62.5	62.9	
Residential Complex	Residential	67.7	60.2	55.0	45.0	63.3	53.2	69.2	63.3	
Hospital Varma	Silence Zone	74.9	74.5	50.0	40.0	63.1	55.4	78.3	61.7	
Residential Complex	Residential	67.7	60.2	55.0	45.0	63.6	53.4	69.7	63.6	

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Receiver	Zone	Corresponding Baseline Noise level		NAAQS		Daytime (L _{dn}) dB (A)	Night-time dB(A) (Leq)	L _{max} dB(A)	L _{eq} dB(A)
		(Leq) dB (A)	Night-time dBA (Leq)	(Leq) dB (A)	Night-time dBA (Leq)				
Residential Complex	Residential	67.7	60.2	55.0	45.0	63.8	53.6	70	63.8
Mosque	Silence Zone	77.1	76.5	50.0	40.0	64.3	55.2	72.7	61.9
Residential Complex	Residential	67.7	60.2	55.0	45.0	63.9	53.7	70	63.9
Hospital Varma	Silence Zone	74.9	74.5	50.0	40.0	63.7	56.1	79.1	62.3
Hospital Varma	Silence Zone	74.9	74.5	50.0	40.0	64.2	56.6	79.9	62.8
Milma Dairy	Commercial	67.7	60.2	65.0	55.0	66.8	56.3	71.8	66.8
Station Metro	Commercial	69.6	69.7	65.0	55.0	70.1	59.3	73.8	70
S N Junction Metro Station	Commercial	71.8	71.7	65.0	55.0	74	63.1	78.7	73.9

The cumulative noise levels presented in noise contour maps as well as represented in the above table depicts, the Noise pressure level was observed to be exceeding the permissible standards of noise levels prescribed by CPCB for daytime and night-time. However, the cumulative noise levels of the proposed metro operation as predicted is well within the noise as compared to the corresponding present baseline ambient noise. The calculations for noise pressure levels have been carried out at grade, this would account to a further drop in the noise level pressure.

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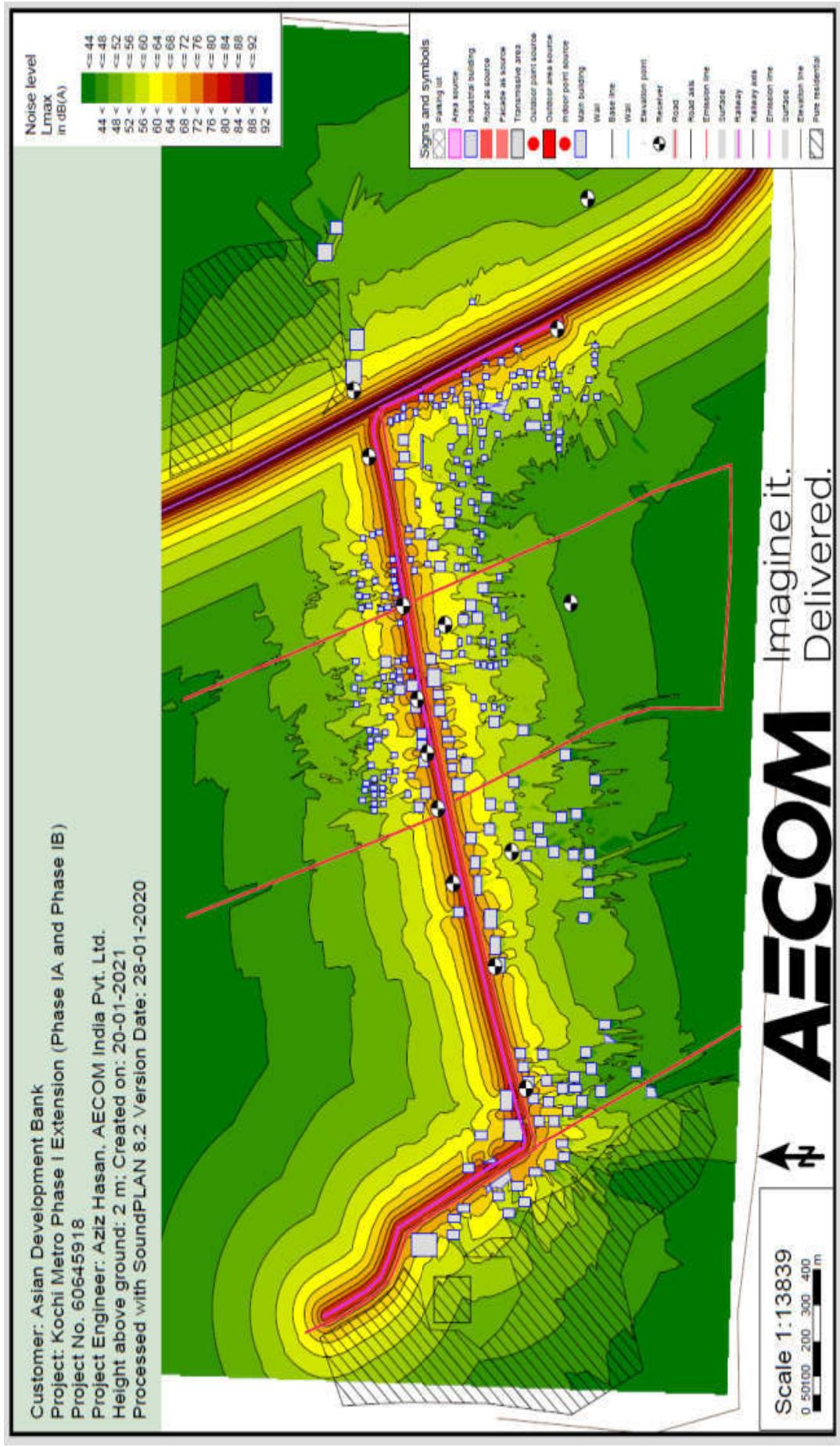


Figure 7-5: Noise Model Map during operation phase

Mitigation Measures

- All elevated and intermediate floors at metro stations shall be provided with sound absorbent and resilient floors to arrest structural and air borne noises at the source itself.
- Ballast less track supported on two layers of rubber pads can be used to reduce track noise and ground vibrations
- In sensitive areas, floating slab can be used to reduce track noise and ground vibrations
- Trackside lubrication can be effective in avoiding wheel squeal, which often occurs as Metro rail vehicles traverses tight-radius curves. This installation automatically deposits a small amount of biodegradable lubricant on the top of the rail, and has effectively eliminated wheel squeal and associated complaints from nearby residents
- To prevent development of surface irregularities on the rail, a fairly heavy rail section is to be used. Further, rail grinding at regular intervals by Rail grinding machine and also lubrication of rail by vehicle mounted lubricator have been contemplated
- Rail shall be continuously welded and also shall be laid to fine tolerances so that any noise/vibration on account of irregular track geometry could be reduced. Rails should be grinded in regular basis to minimize the vibrations
- The vibration generated from rail-wheel interaction will be greatly absorbed by the elastic fastening system proposed to be used. Resilient fasteners are used to fasten the rail to concrete track slabs or ballastless bed.
- A ballast mat consists of a rubber or other type of elastomer pad that is placed under the ballast can be used for reducing vibrations. The mat generally must be placed on a concrete base to be effective
- Other measures which can be taken to reduce vibrations are usage of resiliently supported ties in which concrete ties are supported by rubber pads
- It is suggested that various measures to be adopted to prevent any such damage, such as elastomeric bearings, separating the track desk and the pier, resilient rail fasteners (spring clip, rail pad, elastic pad and compression spring), continuously welded rails, etc. all of which reduce induced vibrations on the surrounding buildings.
- Vibratory machineries, pumps etc. in the proximity of commuters and residences shall be mounted on neoprene anti-vibratory pads to reduce sound propagation.

Significance of Impact

The impact due to noise will have Medium intensity with a medium spread for a Long duration which will result in an overall Moderate impact without mitigation. However, with proper implementation of suggested mitigation the impact will be reduced to Minor.

Table 7-15: Impact Significance – Ambient Noise Quality

Aspect	Scenario	Spread	Duration	Intensity	Overall
Ambient Noise Quality	Without Mitigation	Medium	Long	Medium	Moderate
	With Mitigation	Medium	Long	Low	Minor

7.3.2.3 Visual Impacts and Aesthetics

Anticipated Impacts

Since the metro corridor is elevated section, it may obstruct the views from the nearby buildings. The existence of the metro corridor along the road or along the median in the busy stretch of the roads may also affect the aesthetic value of the area. Further the areas under the viaducts if not maintained may be used by people for dumping waste or may be encroached upon by slum dwellers. Sometime

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outer areas of the stations are also encroached by the slum dwellers. Thus, following measures should be taken to prevent the impact on aesthetics in the area.

Mitigation Measures

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

Significance of Impact

The impact on aesthetics and visual aspects will have low intensity with a local spread for a long duration which will result in an overall minor impact without mitigation. The residual minor impact, even after control of intensity and spread, will remain minor owing to the duration of project.

Table 7-16: Impact Significance – Aesthetic and Visual Impacts

Aspect	Scenario	Spread	Duration	Intensity	Overall
Visual and Aesthetics	Without Mitigation	Local	Long	Low	Minor
	With Mitigation	Local	Long	Low	Minor

7.3.2.4 Impact on Soil Quality

Anticipated Impacts Due to Contamination

At the operation phase there is possibility of soil contamination by spills from accidents or leakage from vehicles carrying hazardous chemicals. The probability of incidents is low and such impacts will depend to a great extent on how such situations are handled on ground. Soil quality at the stations may get impacted if the sewage generated and the waste generated at the stations is not managed properly and is disposed off in open land. As informed by KMRL there would be provision of the septic tanks for disposal of sewage at the stations. Waste to be generated during operation phase will be municipal waste comprising of small quantity of food waste, wrappers of packed food and paper waste from offices. Small quantity of used oil may be generated from DG sets. Measures proposed to be taken for minimizing impact on soil quality are listed below:

Mitigation Measures

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

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recyclable/rejected version should be disposed on daily basis through local agencies in the area responsible for waste management

Significance of Impact

Considering the distribution of impact within the project alignment with Medium intensity makes impact of Moderate significance and can be controlled with the recommended mitigation measures.

Table 7-17: Impact Significance – Soil Quality

Aspect	Scenario	Spread	Duration	Intensity	Overall
Soil Quality	Without Mitigation	Local	Long	Medium	Moderate
	With Mitigation	Local	Long	Low	Minor

7.3.2.5 Impact on Water Quality and Quantity

Anticipated Impacts

At operation phase there is very little chance of deterioration in water quality on streams. This may happen only in case of accidental discharges. Water quality will be affected during operation phase only if the waste/sewage generated is improperly stored and disposed. Sewage or untreated or semi treated effluent and waste should not be stored in unlined pond or other water bodies else it may lead to pollution of ground water. Any spillage if occurs should be cleaned immediately so as it does not get mixed with the run-off and pollute the surface water quality.

Oil spillage during change of lubricants, cleaning and repair processes, in the maintenance Depot cum workshop for maintenance of rolling stock, cannot be ruled out. The spilled oil should be trapped in oil and grease trap. The collected oil would be disposed off to authorised collectors, so as to avoid any underground/ surface water contamination. Wastewater generated during maintenance should be treated in ETP.

Water will be required during operation stage majorly for meeting drinking water requirement of staff, toilets at stations and cleaning & washing of stations. It is proposed that water should be taken from local authorities and if required withdrawn from ground after obtaining permission from CGWA. To minimize the impact on water resources, demand side management should be undertaken so as to minimize the water requirement. The employees and general public shall be made aware on importance of conservation of water through campaigns and awareness drive.

Mitigation Measures

- No area should be left excavated or open after any repair & maintenance works so as there will not be chance of sediments getting mixed with the rainfall run-off
- Disposal of sewage through septic tank at stations and timely evacuation of the septic tanks.
- The contractor shall ensure that hazardous waste is stored separately with spill control kit on impervious surface along with secondary containment with 110% capacity of the waste stored.
- Proper storm water drainage system and rainwater harvesting pits should be provided to harvest the storm water and recharge the same into ground water aquifer system to augment the ground water level and reduce the run-off into the surface water bodies.
- Along with the stations, the pits can be provided at the viaducts to harvest the storm water
- Storm water drains and pits shall be cleared at regular frequency and every year prior start of monsoon.

Significance of Impact

The impact on water resources will be of low intensity with medium spread and long duration for water quality, which will result in an overall minor impact without mitigation. However, impact on water quality can be moderated by mitigation measures, as discussed above.

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Table 7-18: Impact Significance – Impact on Water Availability

Aspect	Scenario	Spread	Duration	Intensity	Overall
Impacts on Water Availability	Without Mitigation	Medium	Long	Low	Minor
	With Mitigation	Medium	Long	Low	Minor

7.3.2.6 Impacts due to Depot

KMRL have a well-established depot- cum- workshop at Muttom. The SN Junction – Thripunithura corridor does not require development of separate dedicated Depot cum workshop facility for the maintenance of the rakes.

The total land used for depot is 23.605 hectares. As informed by KMRL the Wastewater to be generated at depots would be treated by ETP & STP at the Muttom Depot. The treated wastewater shall be recycled for horticulture work of the depot. About 12 KLD of treated wastewater will be used for horticulture and flushing purposes.

The Muttom Depot and maintenance area houses three (03) Borewell and approximately 600 litres per day of ground water would be abstracted for the maintenance operations. As per the Guidelines/Criteria for evaluation of proposals/requests for groundwater abstraction in Kerala, Permission for the construction of groundwater abstraction structures and NOC for withdrawal of Groundwater would be required as the area falls under Safe Category of Ground water resource and as per [groundwater abstraction in Kerala \(With effect from 15.04.2018\)](#), NOC is required for groundwater withdrawal subject to adoption of artificial recharge to groundwater.

Impacts anticipated at depot sites are:

- Water requirement for urinals/closet can be met from recycled water.
- Drinking water requirement cab be met from supply water by local authorities or bottled water supply.
- Impacts caused due to oil spillage during change of lubricants, cleaning and repair processes, in the maintenance Depot cum workshop for maintenance of rolling stock.
- The main source of noise from depot is the operation of workshop. The roughness of the contact surfaces of rail and wheel and train speed is the factors, which influence the magnitude of rail - wheel noise.
- The effluent will have oil, grease and, detergent as main pollutants.

Mitigation Measures

- The contractor shall arrange for water required for construction in such a way that the water availability and supply to nearby communities remain unaffected.
- Water required for domestic and construction use should be taken from sources which have valid permission / permits for the same.
- In case of use of ground water, appropriate permission from Central Ground Water Board should be obtained for the same.
- Installation of meter for its borewell to access the quantity of ground water being abstracted should be initiated .
- All wastes generated at depot will be segregated at source. Different waste collection bin should be provided for different types of waste. A Waste management plans should be developed and includes the method of end disposal of the waste.
- Domestic and construction waste like recyclables viz. paper, plastic, glass, scrap metal waste etc. will be properly segregated and stored in designated waste bins/containers and periodically sold to local recyclers. Non-biodegradable and non-saleable waste shall be disposed of with heap of local municipal waste disposal system.

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- Hazardous waste should be disposed to State Pollution control Board authorised agency only. Packaging, labelling, and transport of hazardous and other waste should to be done as per the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016.
- All the hazardous waste should be handled and disposed as per the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 (as amended).
- Register of all hazardous materials used and accompanying material safety data sheet (MSDS) should be maintained.
- Oil separator/interceptors shall be provided at depot to prevent the release of oils and grease into the drainage system. These shall be cleaned on a regular basis.
- The spilled oil should be trapped in oil and grease trap. The collected oil should be disposed off to authorised collectors, so as to avoid any underground/ surface water contamination.
- A spill prevention and control procedure shall be prepared to identify project components such as storage areas, storage tanks that could allow discharge of oil grease or hazardous materials to the drainage system or ultimately in any water body during spillage. The procedure shall include measures to contain and mitigate transportation of oil, grease or hazardous materials to the drainage system or any water body.
- Oil interceptors shall be used where oily wastes are present.
- The sewage would be treated up to the level so that it could be used for horticulture purpose and can also be discharged into the stream.
- The adverse impacts of vegetation removal could be mitigated through implementing transplantation and compensatory plantations.

Significance of Impact

The impact due to operation of Depot will be of Low intensity with Local spread and long duration for water quality, which will result in an overall Minor impact.

Table 7-19: Impact Significance – Impact on Water Availability

Aspect	Scenario	Spread	Duration	Intensity	Overall
Impacts on Water Availability	Without Mitigation	Local	Long	low	Minor
	With Mitigation	Local	Long	Low	Minor

7.3.2.7 Occupational Health and Safety of Workers***Anticipated Impacts***

During the operation phase, the risks will be quite limited due to nature of operation activities; the activities will be limited to guarding and on call and/or onsite technical support (maintenance and cleaning). There will be potential impacts on personnel's health and safety during operation phase due to exposure to risks such as:

- Slipping and tripping;
- Falling during working at height;
- Exposure to hazards such as electric shock and thermal burn hazards;
- Exposure to chemicals, hazardous and flammable materials; and
- Maintenance activities are expected to be carried out in hot weather conditions; thus, workers are exposed to dehydration, heat exhaustion and heat stroke.

Mitigation Measures

KMRL to prepare and implement Occupational Health and Safety Plan (OHSP) with clearly identified roles and responsibilities of the personnel involved within the project. The OHSP to include but not

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limited to the following: site specific safety plan, electrical safety, fire safety, heat stress, personnel protective equipment, emergency response plan, reporting and investigation and others.

Mitigation measures that will be followed include the following:

- Regular electrical safety training to workers with safety procedures and other safety requirements that pertain to their respective job assignments;
- Implement Lock out/ Tag Out (LOTO) system;
- Use work equipment or other methods to prevent a fall from occurring. Collective protection systems, such as edge protection or guardrails, should be implemented before resorting to individual fall arrest equipment. In addition, safety nets or airbags can be used to minimize the consequences of a fall should it occur.
- Loading and unloading operation of equipment should be done under the supervision of a trained professional.
- All material will be arranged in a systematic manner with proper labelling and without protrusion or extension onto the access corridor.
- Personal Protective Equipment (PPEs) e.g., shock resistant rubber gloves, shoes, other protective gear etc. should be provided to workers handling electricity and related components and monitored that they are used by the employees
- There should be arrangement for hygienic and scientific sanitation facilities for all the labourers working in the site.
- An accident incident and near miss reporting, and monitoring record shall be maintained.

Significance of Impact

The impact on occupational health and safety will have medium intensity with a local spread for a long duration (project duration) which will result in an overall moderate impact without mitigation. However, with proper health and safety measures the intensity of impact can be reduced to low resulting in an overall minor impact.

Table 7-20: Impact Significance – Occupational Health and Safety of Workers

Aspect	Scenario	Spread	Duration	Intensity	Overall
Occupational Health and Safety of Workers	Without Mitigation	Local	Long	Medium	Moderate
	With Mitigation	Local	Long	Low	Minor

7.3.2.8 Impacts on Energy Resources ²⁵

Energy charges of any metro system constitute a substantial portion of its operation & maintenance (O & M) costs. Therefore, it is imperative to incorporate energy saving measures in the system design itself. The auxiliary power consumption of metros is generally more than the traction energy consumed by train movement during initial years of operation. Subsequently, traction power consumption increases with increase in train frequency/composition in order to cater more traffic. The proposed system of Kochi Metro would include the following energy saving features:

- Modern rolling stock with 3-phase VVVF drive and light-weight stainless steel coaches, which has the benefits of low specific energy consumption and almost unity power factor.
- Rolling stock has regeneration features and it is expected that 30% of total traction energy will be regenerated and fed back to 750V dc third rail to be consumed by nearby trains.
- Effective utilization of natural light is proposed. In addition, the lighting system of the stations will be provided with different circuits (33%, 66% & 100%) and the relevant circuits can be switched on based on the requirements (day or night, operation or maintenance hours etc).

²⁵ FEASIBILITY STUDY & DPR FOR KOCHI METRO PHASE - IB

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- Machine-room less type lifts with gearless drive have been proposed with 3-phase VVVF drive. These lifts are highly energy efficient.
- The proposed heavy-duty public service escalators will be provided with 3-phase VVVF drive which gives energy efficiency & improved power factor. Further, the escalators will be provided with infra-red sensors to automatically reduce the speed (to idling speed) when not being used by passengers.
- The latest state of art and energy efficient electrical equipment (e.g. transformers, motors, light fittings etc) have been incorporated in the system design.
- Efficient energy management is possible with proposed modern SCADA system by way of maximum demand (MD) and power factor control.
- Solar power plant may be installed at station to produce electricity which may meet the energy requirement of the station.

7.4 Ecological Impacts and Mitigation Measures

Owing to the Project Site being situated predominantly in modified habitat, foreseeable impacts on biodiversity are relatively minor.

The chief biodiversity risk associated with the Project stems from some of the Project infrastructure and activity being located within or upgradient of a water flow that is ecologically connected to an internationally recognized area designated for its biodiversity value, namely the Vembanad Kol Wetlands Ramsar Site.

Significant biodiversity values associated directly with the Project Site and the estimated area of influence of the Project consist mainly of the minor to moderate ecosystem services being provided by the Champakara River.

Relatively significant biodiversity impacts anticipated as a result of the Project consist of loss or degradation of aquatic habitats owing to the physical presence of Project infrastructure in the Champakara River and chemical pollution of the river water by any contaminating run-offs emanating from the Project.

Biodiversity impacts resulting from the construction and subsequent presence of the Project's bridge piers in the Champakara River ecosystem is likely to lead to accumulation of sediments, alteration of fluvial processes, retardation of water flow, reduction in the navigability of the concerned section of the river .

These primary impacts are likely to trigger secondary effects, such as obstruction of fish passages and degradation of fish breeding sites, leading to moderate loss or degradation of ecosystem services currently accrued by the local community from the river.

Sources: K.J. Gregory, A. Brookes, *Hydrogeomorphology downstream from bridges*, *Applied Geography*, Volume 3, Issue 2, 1983, Pages 145-159.; Ahmed Refaat Bakr, George Yuzhu Fu, David Hedeen, *Water quality impacts of bridge stormwater runoff from scupper drains on receiving waters: A review*, *Science of The Total Environment*, Volume 726, 2020, 138068.; James Davis Reimer, Sung-Yin Yang, Kristine N. White, Ryuuji Asami, Kazuhiko Fujita, Chuki Hongo, Shingo Ito, Iori Kawamura, Isshu Maeda, Masaru Mizuyama, Masami Obuchi, Takashi Sakamaki, Katsunori Tachihara, Maiko Tamura, Akira Tanahara, Aika Yamaguchi, Holger Jenke-Kodama. *Effects of causeway construction on environment and biota of subtropical tidal flats in Okinawa, Japan*, *Marine Pollution Bulletin*, Volume 94, Issues 1–2, 2015, Pages 153-16.; Zhu, Bin & Smith, Daniel & Benauquista, Anthony & Kadapuram, Betsy & Yu, Man. (2014). *Investigating effects of bridge construction on water quality using physical, chemical, and biological analyses*.

Mitigation Measures

Measures to minimize or mitigate the anticipated impacts are as follow:

- Ensuring restoration of the river channel attributes after the completion of bridge pier construction, such as:
 - dismantling of any bunds installed in the channel;
 - appropriate disposal of any solid waste or debris generated during the construction;
 - removal of any geotextile or meshes installed to aid the construction.
- Post-construction monitoring and treatment of the river channel towards:
 - Clearing the river channel of any opportunistic weed infestation triggered by change in the sediment regime; and
 - Flushing out excessive sedimentary deposits which may cause flow blockages.
- Restoration of river-bank vegetation to minimize the amount of sediment entering the channel from surface run-off.
- Implementing a basic run-off management system with respect to the Champakara Bridge to minimize introduction of toxins and contaminants into the river.

7.5 Socio- Economic Impacts and Mitigation Measures

7.5.1 Impacts during the pre-construction phase

7.5.1.1 Impacts due to Acquisition of Land

The project's land acquisition has caused both physical and economic displacement. It has impacted families in 2 villages that are Nadama and Punithura in Ernakulam district of Kerala. As of November 2020, a total of 1.19ha of land is identified for acquisition, out of which 1.11ha is already acquired. (The total land requirement is subject to vary after land identification for Thripunithura station is finalized.) Private land for the project forms 99% of the total requirement and 93% of the total land acquired. The government land forms small proportion of the project i.e. 0.01ha (land for Thripunithura is still under planning; thus, not counted here).

A total of 424 families are affected by the project's land acquisition. Out of which 241 are titleholders. These titleholders are a combination of land losers and land and asset losers. 7 out of 366 families are affected by the road widening, lost only land and no other asset during the land acquisition. Similar bifurcation of 'only land losers' due to land acquisition for Vadakkekotta station is not available.

Important factors related to project land to be noted are:

- Although the category of project land on land record documents (with or without asset) at the time of acquisition, was 'irrigated'; the previous land use has been either residential or commercial or public. Agriculture was not being practiced on any of the land plots as reported.
- Larger part of the government land identified for the project was either occupied by trees or was part of road RoW. There is only 1 government structure (details of the structure are not known) impacted by the project's land acquisition.
- The SIA report mentions potential landlessness being created due to the land acquisition; however, such data is not available in any project related documents shared with AECOM. Moreover, the LA authorities consulted on-site reported that they have not collected or maintain any such data with respect to project affected families. As a result, though specified in the SIA, vulnerability created due to landlessness is not accounted for in the project's compensation and R&R provisions.
- The SIA for road widening suggests that all the non-titleholders considered for compensation and R&R are tenants occupying the structures impacted by the project. This indicates, that encroachers are neither identified nor considered for any compensatory measures of the project. The LA authorities confirmed the same during on-site consultations.
- Moreover, the data with respect to project affected families' total land holding or balance land holding post acquisition is not available either in SIA reports or with the LA authorities. Therefore, identification of marginal and small land holding families cannot be done.

Some of the measures taken by the project to minimise impacts are:

- For Vadakkekotta station, slight changes in the location (either 100meters towards Petta or 100meters towards S N Junction) were considered to minimise number of impacted entities.
- The SIA for road widening identified 3 families belonging to schedule caste or schedule tribe community to be impacted by project. However, the consultations with LA authorities reported no family or person of SC or ST community impacted by the project. This may indicate that the impacts were avoided. However, details are not available.

Mitigation measures:

The ongoing SIA study for Phase IA and IB needs to collect information regarding the total land holding and balance land holding of each project affected person and analyse it to identify any impacts such as landlessness created by the project. If such families are found among project affected, then the SIA to suggest mitigation measures for them.

7.5.1.2 Impacts on Loss of Livelihood

The project's land acquisition has resulted in loss of livelihood for business owners (both titleholders and non-titleholders) and their workers. The impacted business owners account for 71 families and 28 families due to land acquisition for road widening and Vadakkekotta station respectively. These businesses include, ready-made apparel sellers, hotels, electronic device repair centres etc.

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The number of workers engaged at these commercial structures were not initially considered as project affected. However, during public hearing it was suggested by the project affected families to include the workers who lost their livelihood due to impacts on commercial establishments. The LA authorities incorporated the workers among project affected entities and offered compensation. However, there are no records available of the number of workers found to be impacted due to the project. Therefore, there is lack of clarity about whether a re-survey was done to identify all impacted workers or was the compensation disbursed on case-to-case basis. In case of later, the project is likely to have left out a few workers who were eligible for compensation but did not approach the authorities due to lack of information about their inclusion.

Consultations with some business owners near Vadakkekotta station reported that workers with documentary proof of having worked at the commercial establishment for at least 3 years are considered as project affected. However, workers with informal relation with employees which involved cash payment, no pay slips, no tax receipts because they earn less than taxable income etc. were left out of the project due to lack of documentation to prove their livelihood depended on the commercial establishment.

About 6-7 street vendors near Champakara canal were required to move from their original location to a different location for 4-5 months during the road widening for IA and IB. These vendors have returned to their original locations after the period of 4-5 months as understood. However, the temporary impacts on these groups were not studied or considered by the project for any compensatory measures.

Mitigation measures:

- Any person whose primary source of livelihood stands affected by the acquisition of land should be not excluded from the compensation and/or R&R provisions. In keeping with this, it is recommended that a census survey of all project affected entities be done to ensure that all affected persons, with or without a documentary proof, are surveyed and considered for compensation and/or R&R whichever is applicable against the nature and scale of their impacts.
- SIA & R&R needs to look into Any vendors or hawkers restricted from using their selling-location for short-term or long-term period, should be considered as project affected persons and compensated appropriately as per the calculation of their loss.

7.5.1.3 Impacts due to Loss of Access

Loss of access has been identified as a type of impact in both SIA reports. Number of entities subjected to this type of impact are identified to be 3, during the land acquisition for Vadakkekotta station. No details were available in SIA.

Mitigation measures

Project should not lead to loss pf access for any structure

Alternative access should be provided / worked out

7.5.1.4 Impacts of Land Acquisition on Vulnerable Groups (SC, ST, Women headed families)

Both the SIA studies categorised the affected families and persons into specific categories of vulnerable groups. For example, the SIA for Vadakkekotta station has identified economically vulnerable, women titleholders. Whereas the SIA for road widening has identified women headed households, widows, elderly, physically challenged, and mentally challenged.

Table 7-21 Project Affected Vulnerable Groups

Categories of vulnerable families and persons (identified in the SIA)	Families and persons affected by Road widening of IA and IB	Families and persons affected by Vadakkekotta station
Women titleholders	Not known	12
Women headed households	58	Not known
Widow persons	80	Not known

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Categories of vulnerable families and persons (identified in the SIA)	Families and persons affected by Road widening of IA and IB	Families and persons affected by Vadakkekotta station
Elderly persons	239	19 (above 60years of age)
Physically challenged*	05	Not known
Mentally challenged*	02	Not known
Belonging to Scheduled Caste community**	03 (however, LA authorities mentioned no one from SC or ST community is affected due to project's land acquisition)	0
Belonging to Schedule Tribe community**		0
Economically vulnerable	108 (not categorised as economically vulnerable but as per the income criterion applied in Vadakkekotta SIA, these many fall under the category for road widening)	20 (monthly income less than INR 20,000)
Access losers	0	03 (cannot be determined if the number denotes properties or persons)

Source: SIA Reports 2017 and 2019

*Note – Whether this count is of persons or families, is not known.

**Note – The LA authorities reported to have no person/family belonging to SC or ST community among the project affected.

However, as evident from the table above, the categories of vulnerability are not standard in both SIA studies. Moreover, the R&R scheme does not mention any specific provisions for these entities. The only provision for vulnerable groups as mentioned in the SIAs is speedy disbursement of compensation and R&R benefits.

Mitigation measures:

- A detailed census survey of all project impacted entities to be done for all three stations in Phase IA and IB to ensure every vulnerable person impacted by the project is accounted for.
- The vulnerable groups should receive separate/additional provisions of compensation in order to improve their standards of living.
- These provisions may include employment in the project or additional livelihood allowance or capacity building for employability etc. This should align with the ADB standards.

7.5.1.5 Significance of social impacts during pre-construction phase

The impact significance before and after implementation of the mitigation measures recommended in this section, is presented in the table below.

Table 7-22 Significance of pre-construction social impacts

Aspect	Scenario	Extent	Duration	Intensity	Type	Significance
Impacts of Land Acquisition	Prior to mitigation	Local	Long	Medium	Adverse	Moderate
	After mitigation	Local	Long	Low	Adverse	Minor
Impacts on Loss of Livelihood	Prior to mitigation	Local	Long	Medium	Adverse	Moderate
	After mitigation	Local	Long	Low	Adverse	Minor
Impacts due to Loss of Access	Prior to mitigation	Local	Inadequate information	Cannot be determined	Adverse	-

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Aspect	Scenario	Extent	Duration	Intensity	Type	Significance
Impacts on Vulnerable Groups	After mitigation	Local	Inadequate information	Cannot be determined	Adverse	-
	Prior to mitigation	Local	Long	Medium	Adverse	Moderate
	After mitigation	Local	Long	Low	Adverse	Minor

7.5.2 Impacts during the construction and operation phases

7.5.2.1 Impacts on Local Economy and Employment opportunities

The project engaged nearly 350 workers at the time of commencement of construction activities for the IA section. As of November 2020, the requirement has increased up to 500 workers on any given day. There are only 2-3 females in the total workforce, engaged as traffic marshals.

The project has positively created employment opportunities. However, majority of these are immigrants from various states of India temporarily shifted to Kochi for the KMRL project work. The contractors and sub-contractors engaging these workers are understood to be local; therefore, resulting in boost for the local economy. Employing migrant workers that live in Kochi for short-term basis also helps boost the local economy by regular purchase of food supply, electricity, and through local transportation.

During operations phase, the local employment creation is to upgrade to positions of higher income such as ticketing, customer care, housekeeping, and gardening for the metro stations. Security personnel are also proposed to be hired for the stations. An approximate estimation of people to be hired for IA and IB is 150. This is likely to have a larger proportion of females. KMRL has engaged with Kudumbashree Facility Management Centre as a service provider for facility management services at the metro stations. The same provider is likely to provide human resources for IA and IB as well.

Mitigation measures (for construction phase):

The construction phase activities are likely to increase depending upon the completion of land acquisition for S N Junction station and Thripunithura terminal. Considering present workforce requirement of 500 workers is proportionate to the construction of metro track from Petta to Vadakkekotta and bridge over canal; increased construction activities is likely to increase the number of workforces required. In such situation, KMRL can consider giving preference to locals for employment opportunities.

7.5.2.2 Impacts due to Labour Influx

The project engaged nearly 350 workers at the time of commencement of construction activities for the IA section. As of November 2020, the requirement has increased up to 500 workers on any given day. There are only 2-3 females in the total workforce, engaged as traffic marshals. Consultations with the workers on-site indicate that majority of workers are from outside of Kerala. The workers have come to Kochi for KMRL project work from West Bengal, Bihar, Uttar Pradesh etc. KMRL reported to have engaged some workforce locally .

The workers migrated to Kochi from other states for project work, are accommodated in two labour camps provided by their contractor. During the lockdown imposed due to COVID-19 pandemic, the workers had migrated back to their states for a period of 5-6 months. Therefore, any pressure on local health-care services is not likely to have realised due to this influx. However, presently the migrant workers living in the labour camps and working on project sites are exposed to the risk of COVID-19; which is likely to put pressure on the public health-care services in Kochi and nearby areas.

During operations phase, requirement of large migrant workforce is not envisaged. Therefore, the influx is likely to reduce significantly reducing the pressure on local resources.

Mitigation measures:

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- All project workers engaged by all contractors and sub-contractors of the project, to be covered under Employee State Insurance or Workmen Compensation.
- This is to ensure that any worker with minor or major health problem is attended to at the earliest..
- Any person at the time of joining should mandatorily tested for COVID-19 under RT-PCR test from ICMR approved laboratory. Only persons whose test results are negative, shall be appointed for work.
- Any worker showcasing symptoms of COVID-19 should undergo the same test at the contractor's cost. If positive, the Kerala state norms of quarantine shall be applicable to the worker. The worker should be paid his full salary during the quarantine period.

7.5.2.3 Impacts of Traffic Congestion

Construction of the metro has restricted vehicular traffic to single lane on both sides for a stretch of nearly 1km. This restriction is likely to increase up to 3km upon commencement of construction activities for two more metro stations. This has increased the traffic congestion on the road leading to delays in commute, increased air pollution, and civic inconvenience.

Every year during November-December thousands of worshipers visit the Sree Poornathrayeesa temple (located 900m from proposed Vadakkekotta station) for 'Vrischikotsavam' festival; however, due to COVID-19 the same has been cancelled in 2020. This year's construction activities are not to be impacted by the traffic planning due to this event.

KMRL has undertaken preparatory work to minimise the negative impacts of increased traffic congestion during construction phase. Such as widening the road on both sides to allow vehicles to pass and to build a bridge over Champakara canal to divert the traffic on existing bridge which would be used for transportation of material and workforce for the construction of metro track/viaduct passing over the canal.

Although the road widening has created space for vehicles to continue using the road; many structures have lost their parking areas during the land acquisition for the road widening. Because of this, vehicles are being parked on main roads leading to further traffic congestion and nuisance for travellers.

During operations phase, the project related transportation activities will be discontinued. Furthermore, the existing traffic congestion on the road will also be diverted due to travellers commuting by metro. Therefore, during operations phase, the traffic congestion on the road is likely to reduce significantly.

Mitigation measures:

- It is recommended that the project completes its activities meeting the scheduled timelines to avoid long-term effects of traffic congestion on the road.
- A detailed plan shall be prepared for traffic management including details on closure of roads, requirement of signages and details of diversion of traffic and same shall be shared with the public through appropriate media including newspaper (local & English language), National television and through radio at least 1-week prior diversion
- Provision of access pathway & adequate parking areas for construction material vehicle and debris carrying vehicle at construction site, storage yards & casting yard to be carried out, and should not be parked on road especially during peak traffic hours
- Regulating the time of vehicle carrying construction material & debris to avoid peak traffic hours
- Drivers should be given instruction for not over speeding the vehicle, not overtaking other vehicle, not to drink and drive and to do lane driving to minimize the chances of accidents. Drivers should be penalized in case any such activity is reported. Accidents may disturb the traffic badly. Drivers shall be trained for defensive driving practices
- Routes and time should be designated for movement of the transportation vehicle and same shall be strictly followed

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- Contact number of EHS cell officials, movement path and timing should be displayed on the vehicles carrying construction material and debris so as complaints can be reported against the vehicle if any unfair activity is seen by the drive
- Obtaining all required permits from RTO prior to partial/full closure or diversion of any road.
- Proper barricaded with LED lights on top shall be provided along the construction area and traffic marshals shall be deputed in major traffic areas like junctions, roundabout, circles etc. to manage and guide the traffic
- Proper signage shall be provided to inform people about the diversion/blockage
- All the diverted routes/roads shall be restored back to original condition after completion of construction works.

7.5.2.4 Impacts on Community Health and Safety

The construction phase of the project involves handling of heavy material, transportation of material and workforce. This increases the likelihood of road accidents, increases levels of air and noise pollution. The operations phase of the project is also likely to increase the levels of noise and vibration for the community adjacent to the metro alignment.

To minimise the impacts on and due to traffic congestion, the project has undertaken road widening and construction of bridge over canal to avoid the impacts. The material being transported is covered to avoid spills and falls. The area exactly below the under-construction metro track is fenced to avoid entry of locals inside, to avoid cases of accidents due to falls.

KMRL does not currently have any formal plan to engage with the stakeholders on regular basis. The communication between KMRL and locals has been limited to the public hearings for land acquisition and any intermittent interaction with the local self-governments for permissions and clearances. Considering the lockdown conditions due to COVID-19 pandemic, as of November 2020 the construction of three stations is delayed. For the extended construction period and smooth transitioning from construction to operations phase there is need to set up a formal engagement system between project proponent and its stakeholders.

In addition, there is currently lack of a formal grievance management system for external stakeholders such as the local community. KMRL has started a helpline which is common for all Phase I, IA, IB and Water metro projects. However, based on consultations with the local community, majority locals are not aware of this service. Those who have raised complaints over the helpline have reportedly not received a call back whether for an acknowledgement or solution.

Mitigation measures:

- It is recommended that formal systems for Stakeholder Engagement and Grievance Management are developed specially catering to the external stakeholders of the project.
- Please refer to sections *Ambient Air Quality, Ambient Noise Quality, and Traffic and Transport* for recommendations to minimise impacts on air, noise pollution and on traffic management.

7.5.2.5 Significance of social impacts during construction phase

The significance of impacts before implementation of recommended mitigation measures and residential impact after implementation of the mitigation measures is presented in the tables below, separately for construction and operations phases.

Table 7-23 Significance of construction phase social impacts

Aspect	Scenario	Extent	Duration	Intensity	Type	Significance
Impacts on Local Economy and Employment Opportunities	Prior to mitigation	Local	Short	Medium	Adverse	Minor
	After mitigation	Local	Short	Medium	Positive	Minor
Impacts due to Labour Influx	Prior to mitigation	Local	Short	Medium	Adverse	Minor
	After mitigation	Local	Short	Low	Adverse	Insignificant

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Impacts of Traffic Congestion	Prior to mitigation	Local	Medium	Medium	Adverse	Moderate
	After mitigation	Local	Short	Low	Adverse	Insignificant
Impacts on Community Health and Safety	Prior to mitigation	Local	Short	Medium	Adverse	Minor
	After mitigation	Local	Short	Low	Adverse	Insignificant

7.5.2.6 Significance of social impacts during operations phase

Aspect	Scenario	Extent	Duration	Intensity	Type	Significance
Impacts on Local Economy and Employment Opportunities	Prior to mitigation	Local	Long	Low	Positive	Minor
	After mitigation	Local	Long	Low	Positive	Minor
Impacts of Traffic Congestion	Prior to mitigation	Local	Long	Low	Positive	Minor
	After mitigation	Local	Long	Low	Positive	Minor
Impacts on Community Health and Safety	Prior to mitigation	Local	Short	Medium	Adverse	Minor
	After mitigation	Local	Short	Low	Adverse	Insignificant

7.6 Disaster and Climate Change Risks Screening Tool²⁶

ADB screening tool has been designed to consider climate induced risks and natural hazards of geophysical origin. This screening tool helps to expand the ADB's risk assessment capacity within its policy framework and project life cycle operations. ADB has developed this risk screening tool to rapidly assess impacts and associated risk at the project preparation stage. The checklist presents a set of questions, answers to questions in the risk screening tool, when totalled generate a risk value of High, Medium or Low.

Table 7-24: Climate and Disaster Risk Screening

Risk Assessment Category	Risk Value	Total	Remarks
Pre-determined impacts and risk factors			
Which physical environment best describes the project area	The score for the physical environment which best describes the project location. 1	The region falls under humid and sub-humid plains, foothills and hill country. The region experiences more than 500 mm precipitation/yr. The project would be established on built up land, with a few agricultural patches. The area falls in Zone III: Moderate Damage Risk Zone of getting affected due to earthquakes.	
Categories sectoral risk of project (See Appendix W: Risk by sector)	Add risk value from 0-3	2	Transport
List individual hazards that may impact project	Risk value of natural hazard. 2	The area falls in Zone III: Moderate Damage Risk Zone hence low risk of getting affected due to earthquakes. The area experiences heavy rainfall and hence flash floods are a common phenomenon.	
Estimate the number of people in the project area "exposed" to risk after the project is completed.	For <100 score = 0, 100-1000 score = 1, 1000-10,000 score 2; >10,000 score = 3	3	Population exposed to risk in each town is more than 10,000.
Stakeholder engagement and risk knowledge			
Do the project proponents have the institutional capacity to successfully incorporate, manage and deliver risk management measures to the project	Yes/No (If good capacity then adds 0; if poor capacity adds 1 risk value; if very poor capacity add 2 risk values) 1	The major risk related to project would be a natural disaster -earthquake and hence KMRL team onsite should make coordinated efforts with district disaster risk management authority to take control of the situation, when in time of need.	
Will potential hazard impacts on communities, gender, indigenous people or	Yes/No (If No, add 1 risk value). If Unsure, add 1 risk value 1	Impacts on gender and indigenous people are not considered from the hazard perspective (flood, earthquake and landslide).	

²⁶ ADB Portfolio at Risk, (updated to 2009 Sector classification)

Risk Assessment Category	Risk Value	Total	Remarks
the social dimension of risk be considered in the concept.			
Are there any demographic or socio-economic variables (i.e. population increase, settlement patterns, bio-physical/environmental conditions) that may increase exposure to hazard impacts	Yes/No (If yes, add 1 risk value). If Unsure, add 1 risk value	1	There may be some rural sprawl of population in the next ten years from now, which might be impacted. The area experiences heavy rainfall and hence flash floods are a common phenomenon, which would continue in the coming years. Kochi being a coastal city, will bear the brunt of rise in sea level due to climate change.
Is it likely that Executing Agency stakeholder(s) has some practical knowledge of risk reduction measures for the project?	Yes/No (if No, add 1 risk value). If Unsure, add 1 risk value	0	Yes, KMRL/KEC-CCECC team has capacity of risk management at the stage of project development. KMRL and KEC-CCECC have developed Monsoon Preparedness plan.
Will the project reduce, leave unaltered, or increase the risk to project beneficiaries?	Reduce risk, score = 0, Leave risk unaltered, score = 1, Increase risk, score = 2.	1	KMRL will have no control on reducing the natural disasters, hence the risk related to natural disasters will remain altered.
Will the project reduce, leave unaltered, or increase the risk to the localized environment/project dependent ecosystem?	Reduce risk, score = 0, Leave risk unaltered, score = 1, Increase risk, score = 2.	1	KMRL will have no control on reducing the natural disasters, hence the risk related to natural disasters will remain altered.
Do country/institutional policies or environmental laws significantly promote risk management measures?	Yes/No (if No, add 1 risk value). If Unsure, add 1 risk value	0	Yes, the country institutional policies and environment laws significantly promote risk management measures.
Does the Project require a risk expert to introduce risk reduction measures in project design, implementation, or operations and maintenance?	Score = 0 for No. Score either 1 or 2 for Yes (based on your assessment of the level of risk).	1	
Total Risk Value (Range 0 to 25)		14	Moderate Risk
High Risk: between 17-25			
Moderate Risk: between 8-16			
Low Risk: between 0-7			

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Low Risk (0-7): This range indicates the Project proposal has considered risk management measures to minimize hazard impacts and associated risks, and that the Project may therefore have a potentially higher threshold against current and anticipated risks.

Moderate Risk (8-16): Project exposure to Risk is **likely**. It is **recommended** that risk reduction measures be incorporated into project design and activities.

High Risk (17-25): Project exposure and vulnerability to potential Risks is **very likely**. It is **highly recommended** that risk reduction measures be incorporated into project design and activities, and that a further review of the Project **proposal be undertaken**.

In accordance with the Climate and Disaster Risk Screening tool the Project is computed to be “**Moderate Risk**” in terms of climate induced risks and natural hazards on the project. It is recommended that risk reduction measures be incorporated into Project design and activities.

Climate change is projected to increase the frequency and intensity of some extreme weather events. Specifically, sea level rise could amplify storm surges in coastal areas, and precipitation will likely be more intense. These changes could increase the risk of delays, disruptions, damage, and failure across the project cycle. Most Metro infrastructure being built now is expected to last for many years. Therefore, it is important to understand how future climate might affect these investments in the coming decades.

Mitigation Measures

- A sound disaster management plan needs to be adopted to counter the risk of natural hazards.
- Increase in rainfall intensity and the vulnerability to flooding will be considered in designing
- The project will include the development of storm water drains.
- Retention capacity of the existing storm drains to which project storm drain will be connected, need to be checked, this will help to mitigate in a minor way the impact of flash floods.
- The project will incorporate, during detailed design, adequate mitigating measures for these risks related to floods and climate change.
- Ensure enforcement of national building codes to reduce disaster risks.
- KMRL team onsite should make coordinated efforts with district disaster risk management authority to take control of the situation, when in time of need.

8. Environment and Social Management Plan

8.1 Introduction

The purpose of an Environmental and Social Management Plan is to ensure that social and environmental impacts, risks and liabilities identified during the ESIA process are effectively managed during the operation and closure of the proposed project. An Environmental and Social Management Plan (ESMP) is an important component of an ESIA as it provides an important tool that can be used to measure and check, in a continuous mode, the efficacy of the mitigation measures and project commitments incorporated in the ESIA to minimize or eliminate identified negative impacts. The ESMP also aligns the schedule for implementation of management plans.

The key objectives of the ESMP are to:

- Formalize and disclose the program for environmental and social management;
- Provide a framework for the implementation of environmental and social management initiatives;
- Monitor the project management's compliance with all the mitigation measures and commitments in the ESIA report;
- Monitor the project management's compliance with legal standards and limits for discharges, disposals and emissions;
- Provide early warning signals on potential environmental changes, so that appropriate actions can be taken to prevent or minimize environmental and social impacts;
- Put in place a sound and cost-effective contingency plan that can be activated for prompt response to any accidental occurrence;
- Encourage and achieve the highest environmental and socio-economic performance and response from individual employees and contractors throughout the duration of the project; and
- Routinely check all measures/devices put in place for effective monitoring of project functions and activities.

The ESMP delineates the monitoring and management measures to avoid and/or minimize such impacts by allocating management responsibility and suggesting skill requirement for implementation of these measures. Also, the ESMP shall ensure a continuous communication process between the project proponent, project developer, workers (including sub-contractors), local community and other stakeholders.

In addition, the ESMP may also be used to ensure compliance with statutory requirements, and corporate safety & environmental and social management policies.

An ESMP is, therefore, a tool which ensures continuous assessment of the environmental and social impacts of a project operation as well as proactive response to the impacts to reduce their overall effect on the identified environmental and social parameters. It makes an organization to do the right thing at the right time rather than responding to situations borne out of statutory or legal compulsion.

In this section, an ESMP is presented to be used throughout the life span of the proposed project. This ESMP will facilitate environmental and social management of the proposed project and outlines the procedures to prevent, avoid or minimize negative environmental impacts that may occur during project operations phase.

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8.2 Organizational Structure (Environment, Social, Health and Safety)

8.2.1 Corporate Level Organisational Structure

Kochi Metro Rail Limited (KMRL) is a Special Purpose Vehicle (SPV) that has been formed by the Government of Kerala, for execution and operation of the proposed expansion of Kochi Metro phase I from Petta to Tripunithura.

KMRL, at the corporate level, is headed by the Managing Director (MD). Chief Executive officer (CEO) and Chief Financial officer (CFO) report to MD.

8.2.1.1 KMRL Safeguard Cell

KMRL has established a safeguard cell headed by Director (Projects) which helps to monitor the EHS related management. Safeguard cells of KMRL works in coordination with Contractor SHE cells to ensure implementation of the EMP and safety procedure.

The EHS functions at the corporate level is managed by Director (Projects). General Manager Projects (KMRL) who has been assigned the overall responsibility to oversee the projects EHS functions of all the metro project, both new Projects as well operational sites reports to Director (Projects).

The Team Leader of Project Management Consultancy (PMC) for specific project reports to General Manager Projects of KMRL. Team Leader (PMC) is supported by Deputy Team Leader Projects and Deputy Team Leader Systems. Senior Engineer EHS (PMC) reports Deputy Team Leaders and looks after overall EHS management with help of EHS Engineers. The management team from Kochi Metro Rail Limited (KRML) responsible for project execution is listed below:

- Shri. Thiruman Archunan, Director - Projects
- Shri Kumar K R, Director -Finance
- Shri. Vinu C Koshy, GM (Projects)
- Smt Seenii Alex, Addln GM (F&A) (Finance)
- Shri Rizwan T , Manager (Civil) (Projects)

Figure 8-1 illustrates the KMRL Safeguard Cell Organization Structure.

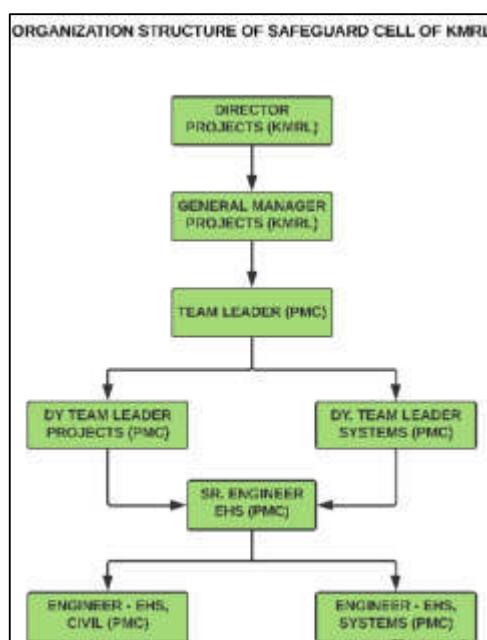


Figure 8-1: KMRL Safeguard Cell Organization Structure

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8.2.2 Project Level Organisational Capacity (EPC Contractor)

The EPC contract for Phase IA was awarded to KEC- CCECC JV and the work started in October 2019. The contract for Phase IB was awarded to KEC – VNC JV.

As per contract document of KEC- CCECC JV shared with AECOM, it was observed that at the project level KEC- CCECC JV is headed by a Project Manager who is responsible for completion of the project with total implementation of the company's SHE policy requirement, SHE management system & requirements of EHS plan and comply with the relevant statutory rules and regulations. The Chief SHE Manager reports to the Project Manager and looks after dissemination and communication of SHE policy, SHE management system requirements to site personnel. The different team members who report to Chief SHE Manager are as follows:

- **Junior SHE Manager:** Reports to Chief SHE Manager on all matters pertaining to status of SHE at site level. The responsibilities include managing safe performance of construction activities on site and providing advice on matters pertaining to EHS.
- **Section / Area In-charges:** Ensures that all the engaged workmen are selected through the screening system & have undergone SHE induction before starting any task at site.
- **Occupational Health Officer:** Ensures medical screening for the new joiners & all workforce engaged by KEC- CCECC along with subcontractor's workmen. The responsibilities include renders treatment of minor injuries, renders first aid treatment for the purpose of preserving life and minimizing the consequences of injury and illness, creating awareness among the staff and workmen about occupational health issues & remedies, etc.
- **Environment Manager:** Sets up an environmental team to execute the environmental requirements. Duties of environmental team include monitoring of the various environmental parameters, inspect, investigate and audit the work methodology with respect to environmental mitigation and control.
- **Labour Welfare officer:** Understanding the welfare requirements of the workmen, fulfilment of required needs along with providing EHS trainings and PPE requirements comes in responsibilities of labour welfare officer.

At each section level safety stewards are provided at the site who are responsible for verifying & conducting the toolbox meetings at regular intervals at every activity.

All the site officers would in turn report to the Chief EHS Manager. The Chief EHS Manager will receive on-site reports from Site Safety in Charges which he/she will report back to the Project Manager. The overall responsibility of managing quality and EHS aspects for the project is assigned to the Project Manager, who in turn reports to the KMRL safeguard cell at the corporate level. The Project Manager at site level shares weekly and monthly compliance report to KMRL safeguard cell. A monthly EHS meeting takes place between the KMRL safeguard cell and the contractor EHS committee/team to discuss the EHS aspects of the project. Figure 8-2 illustrates KEC- CCECC JV's SHE organization structure.

Organization structure with project level responsibilities as shared in KEC International's Project Occupational Health, Safety & Environment Plan, dated 5th November 2020 is illustrated in Figure 8-2.

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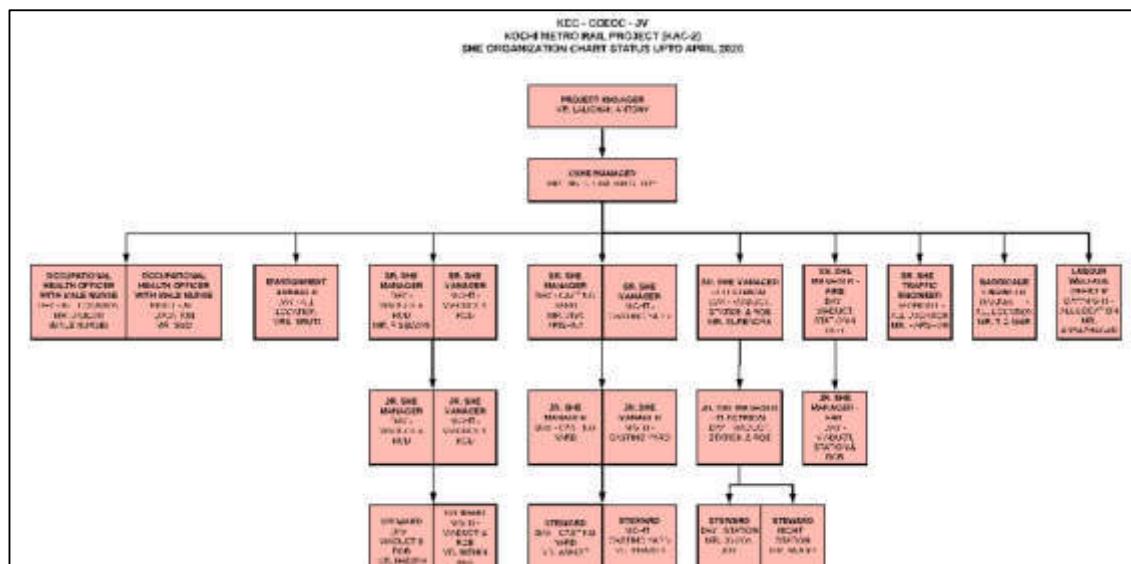


Figure 8-2: Organization Chart

Source: Project Occupational Health, Safety & Environment Plan, dated 5th November 2020

8.3 Roles and Responsibilities

This section outlines key roles and responsibilities of the key persons responsible for management environmental and social aspects and management plans of project activities as detailed in the Project Occupational Health, Safety & Environment Plan, dated 5th November 2020.

Project Manager:

- Responsible for total implementation SHE policy, SHE Management System requirements and relevant statutory rules and regulations for entire duration of the project. Key responsibilities include:
 - Screening of workmen by site execution engineers.
 - SHE Induction for all staff & workmen by SHE Engineer / Officer.
 - Regular monitoring and recurring in-house SHE trainings.
 - Ensure that all staff & workmen are competent to perform their tasks safely
 - Ensure sufficient resources are available at site by:
 - Reviewing SHE Plan implementation and discussing outstanding issues
 - Investigating non-compliance and non-implemented items.
 - Site SHE Inspection and SHE Plan implementation monitoring
 - Investigation of all high potential incidents and non-compliance issues and ensure immediate remedial action to stop recurrence.

SHE Manager/ Chief SHE Manager:

- Disseminate and Communicate SHE Policy, SHE Management System requirements to site personnel.
 - Advice and support in the effective implementation of the SHE Management System requirements.
 - Internal SHE is training programs, promote SHE awareness and performance
 - Inspections and risk-based assessment of the project.

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- Assist in preparing Hazard Identification & Risk Assessment (HIRA)
- Implement Work Permit Systems.
- Provision & inspection of PPE & safety devices
- SHE inductions and screenings.
- Conduct Fire Drills and Emergency Mock Drills to cover various contingencies such as fall from height/ food poisoning / electric shock, etc.;
- Procure, inspect and maintain Fire Extinguishers.
- Maintain all SHE related documents and training records

Occupational Health Officer:

- Responsible for obtaining valid first aid certificate and prominently displaying it on site
- Monthly check of all first aid boxes
- Maintenance of first aid treatment room
- Maintain log of all treatments
- Participate in All emergency drills and exercises.
- Investigate accidents/incidents
- Arrange periodic health check-ups for all employees & Workmen
- Organize health camps for employees & workers.
- Set up ties with nearby hospitals for any medical emergency or trauma.
- Association with authorized waste disposal vendors for biomedical waste disposal.

Environment Manager:

- Set up an environmental team for implementation of environmental management plans.
- Oversee monitoring of various environmental parameters, inspect, investigate and audit the work methodology with respect to environmental mitigation and control
- Anticipate environmental issues before they arise and provide mitigation measures for it
- Prepare periodic site inspection/audit reports
- Instruct site staff & subcontractors to increase awareness and draw attention to environmental management issues.
- Participate with the SHE Engineer / Officer or the committee Members in the Project SHE Inspection
- Report all near miss cases / reportable LTI /dangerous occurrences / fatality to environmental Engineer immediately verbally & submitting the preliminary accident report within 12 hours.
- Informing the concerned authority as per the emergency response plan.

Labour welfare officer

- Understand the welfare requirements of the projects
- Enforce use of necessary personal protective equipment
- Eliminate all unsafe conditions
- Enforce good housekeeping to keep work area neat & clean
- Assess critical activities based on the Group Risk Assessment and ensure implementation of the Risk control measures.
- Participate with the SHE Engineer / Officer or the committee Members in the Project SHE Inspection

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- Follow all work permit system
- Report all near miss cases / reportable LTI /dangerous occurrences / fatality to SHE Engineer immediately verbally & submitting the preliminary accident report within 12 hours.
- Informing the concerned authority as per the emergency response plan.

All employees

- Report all unsafe acts and condition to the immediate supervisor.
- Start work only when conditions are safe and stop work when it is unsafe.
- Operate equipment only when authorized and prescribed manner. (If applicable)
- Report any injury or accident immediately.

8.4 Inspection, Monitoring and Audit

8.4.1 Inspection

The following four SHE inspections programs are mandated by the Project Occupational Health, Safety & Environment Plan, dated 5th November 2020:

8.4.1.1 Planned General Inspection

Periodic Planned general inspections performed by contractors include:

- Monthly Contractor inspections and subcontractor's site safety committee Inspection.
- Weekly site safety inspection by Project Manager and Supervisory staff.
- Daily safety inspection by Contractor SHE team.

8.4.1.2 Routine Inspection

Routine inspections include work site inspections, equipment inspections and inspections of temporary structures performed by site and equipment operators and temporary structure erectors. Inspections that will be classified under this inspection program are:

- Daily Inspection of plant and equipment by operator
- Weekly Inspection of scaffold by scaffolding supervisor
- Monthly Inspection of electrical hand tools by competent electrical supervisor
- Quarterly Inspection of temporary electrical systems by competent electrical supervisor
- Six-monthly inspection of lifting machinery, lifting appliances, equipment and gears by Govt. approved competent person.

Routine periodic inspections are mandated for all equipment, powered tools and any other temporary structures that may pose a hazard to operators and workmen.

8.4.1.3 Specific Inspection

Contract will arrange to followings inspections at required locations for non-routine activities.

- Major road diversions, pipeline diversions & electrical utility diversions etc.
- Shifting of any major setups of the project i.e. container, office setup.
- New hired or own equipment is engaged at site for the first time.
- Before establishing the Casting Yard & Batching Plant locations.

8.4.1.4 Other Inspection

Other inspections should include the following:

- Mandatory Inspections by Labour Department of Government.
- KMRL site inspection on contractor SHE management and implementation.

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8.4.2 Monitoring

8.4.2.1 Monitoring and Reporting carried out for the project

An Environment Monitoring plan (EMP) has been prepared as part of EIA, prepared for the project. The EMP has been included in the contract agreement to the EPC contractor to implement the same for the project. As per the contract agreement the EPC contractor has prepared an Environment Monitoring plan for the project.

Baseline environmental monitoring has been conducted for the projects as part of the EIA study. Further, monitoring of ambient air, noise, water and wastewater, soil, DG stack etc. is being undertaken by the EPC contractor undertaken during construction stage to identify impacts.

As specified in the contractor agreement KEC-CCECC carries out environment inspection of works and submits to KMRL, a weekly report as per format provided. The area of inspection includes environmental compliance within the site but also areas outside the site which are likely to be affected, directly or indirectly by activities at site. Results of inspection is discussed with KMRL.

KEC-CCECC carries out monitoring for:

- Tracking of project-wide environmental parameters with respect to air, water & effluent, soil, noise etc.
- Tracking of resource consumption such as water, energy, raw materials etc.
- Monitoring progress of objectives and targets,
- Calibration of environmental data measuring devices and
- Monitoring legal compliance.

Where it is determined that the impact of construction works on the site are material or if unacceptable, adverse impacts occurred as a result of carrying out monitoring or in case of any complaint, by the public, applicable Municipalities, Governor's office or other public and private agencies, monitoring frequency is modified accordingly.

It was reported that review meetings are conducted once every month between KMRL's safeguard cell and Project manager/ Chief EHS manager of KEC-CCECC. The EPC contractor shares monthly compliance report to KMRL Safeguard cell. A compliance reports by KEC-CCECC's SHE management reports are submitted to KMRL periodically which include the following:

- Daily Reporting of total no of workmen
- Monthly SHE Report
- SHE Committee Meeting Minutes
- SHE Inspection Reports
- SHE Audit Reports
 - Monthly Audit Rating Score (MARS) report
 - External SHE Audit
 - Electrical Safety Audit
- Air and Noise Quality monitoring report.

KEC-CCECC JV also prepares a monthly SHE reports consisting of the following and submit 3 copies within 7th of every month to the KMRL as specified in the Project contractor agreement.

- Monthly man-hour details as specified in the Project SHE manual.
- Monthly accident / incident details as specified in the Project SHE manual.
- SHE committee details.
- Details of SHE training conducted in the month.
- SHE Inspection.

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- SHE internal audit details like electrical audit etc.
- SHE Communication activities undertaken in the month indicating the number of posters displayed and balance availability in stock.
- Air quality / Noise monitoring details.
- Toolbox talks details.
- PPE details: Quantity purchased, issued to the workmen and stock available.
- Details on IP 44 panel boards, lighting poles, welding and cutting equipment's, Ladders, Hoists, tools & tackles.
- Monthly Lux meter study results.
- Housekeeping.
- Barricade maintenance details.
- No of critical excavations.
- Health & Welfare activities.
- Safety walk conducted by KEC-CCECC JV Project Manager in the month.
- SHE Activities Planned for next month.

The KEC-CCECC submits to the KMRL an Air Monitoring and Control Plan (AMCP) under contract specific Site Environmental Plan to guide construction activity as it relates to monitoring, controlling and mitigating air pollution.

KEC-CCECC also submits to the KMRL, a Noise Monitoring and Control Plan (NMCP) under contract specific Site Environmental Plan. It includes comprehensive details of all powered mechanical equipment, to use during daytime and night-time and of his proposed working methods and noise level reduction measures. The NMCP provides detailed noise calculations and vibration levels to demonstrate the anticipated noise generation and vibrations.

8.4.2.2 Monitoring at corporate level

KMRL should conduct an independent internal environment audits in accordance with the Employer's Requirements. This audit shall be completed using the KMRL Audit Criteria & Guidance document copies of which shall be provided by the KMRL.

It is understood that all departments prepare a quarterly update of their performance, which is put together as an internal Quarterly Report by the legal department and submitted to the Board of Directors (BoD)s. Copy of such a report could not be shared for review with AECOM. However, as mentioned it includes details of work done, timelines, expenditure, health and safety update, labour and working conditions, status of grievances etc.

8.4.3 Audit

As per Project Environment Management Plan dated May 12, 2020, the following audits are conducted and documented in the lifecycle of the project.

- MARS Audit: Conducted once a month by PM along with their team and Employer's representative. Report shall be submitted in the MARS format.
- External SHE Audit
- IMS/ ISO/OHSAS Audit: Conducted as per requirement.

8.4.3.1 Internal Audit

A team consisting of Project Manager and KMRL representative should carry out audit based on the pre-designed score-rating format (provided in Project SHE manual of KMRL) in accordance with KMRL Guidelines. Contractor SHE manager is also invited to attend. MARS should be conducted at least 7 days prior to monthly SHE committee meeting. The audit team uses their observations noted in evaluating the points to be awarded against each of the elements of the audited section for

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applicable sections. The timeline to rectify an error depends on the score ranging from within 24 hours for less than 60%, within 7 days for less than 75% and within one month for less than 90%.

8.4.3.2 External Audit

External third-party EHS and labour audit should be undertaken by KMRL at least once every year by a appointed by the corporate in consultation with the site to track and access the performance of the EPC contractor and the effectiveness of their policies and procedures along with onsite implementation. The external agency should have prior experience of undertaking external audits of stakeholder activities and encompass team members possessing requisite educational qualification.

External competent ISO qualified auditors are to conduct quarterly external audits as per the guidelines of ISO, ILO, and national standards with the prior approval of the KMRL. If the contractor fails to conduct the external, SHE audits in time, the Employer at the cost of contractor shall get it done.

8.5 Documentation and Record Keeping

As per Project Environment Management Plan dated May 12 2020, the following Environmental Records shall be maintained at site.

- Waste Management Record
- Environment Monitoring reports
- Environmental Inspection Report
- Environmental Training & Toolbox Record

The Following Environmental Reports shall be submitted to KMRL. A separate Environmental Monthly Report with the following content shall be submitted:

- Executive Summary
- Ambient Air, Noise & Drinking water Monitoring Results
- Analysis of Air, Noise &Drinking water Monitoring Results
- Waste Disposal Record
- Environmental Inspection Report
- Environmental Training & Toolbox Records
- Good Environmental Practices

Documentation and record keeping system has to be established by KMRL to ensure updating and recording of requirements specified in ESMP. Responsibilities have to be assigned to relevant personnel for ensuring that the ESMP documentation system is maintained and that document control is ensured. The following records shall be maintained at site:

- Documented Environment Management System;
- Legal Register;
- Operation control procedures;
- Work instructions;
- Incident reports;
- Emergency preparedness and response procedures;
- Resource consumption Records;
- Training records;
- Monitoring reports;
- Contractor agreement compliance report and its closure report
- Auditing reports; and

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- Complaints register, and issues attended/closed.

8.6 Capacity Development and Training

KMRL functions in three main verticals, Projects, Operations and Maintenance and Water Metro. The total employee strength across the verticals as of November 2020 is 515. As reported, there are 72 female employees, representing 13.98% of women in KMRL workforce. For other key functions especially for the Phase IA and IB such as Land Acquisition, KMRL engaged third party consultants on short term basis. The outsourced team engaged by KMRL for undertaking SIA also involved women for easy and smooth communication with stakeholders, particularly women PAPs.

The Human Resources department of KMRL is responsible for the recruitment, maintenance (welfare of employees, salary, administration, performance assurance and evaluation, disciplinary actions toward employees), and separation (natural, accidental, and resignation). The department is headed by the Chief General Manager Human Resources.

The HR Policy handbook is given to every new joinee and every employee has access to the HR Policy on the organization's internal portal, as understood from the HR team representative and select employees. The HR Policies cover working hours; leaves; different employee entitlements including medical insurance, gratuity; anti-workplace harassment; grievance redressal etc. KMRL has 2 separate committees for handling general complaints and concerns related to workplace harassment.

8.6.1 Training

Training is one common method of supplying individuals with additional skills and knowledge. In order to be successful in EHSS management, training programs need to be thought out carefully and systematically. A robust social and environmental, health and safety training plan is important for effective implementation of ESMS.

The chief HSE Manager along with recommendations from KMRL will ensure that the job specific training and EHS induction training needs are identified based on the specific requirements of the ESMS and existing capacity of site and Project personnel (including the Contractors and Sub-contractors) to undertake the required actions and monitoring activities. Some of the specific trainings that will be carried out routine basis are as follows:

- ESMS Checklists and procedural guidance;
- Occupational Health & Safety;
- Fire Safety and Prevention;
- Emergency Response Preparedness;
- Operational Training;
- HR Induction Training;
- PPE Training;
- Driver Safety; and
- Implementation of Environmental and Social Management/Action plans

The above listed trainings are the preliminary trainings which will be undertaken at the inception stage once the employee/worker joins the company and/or Project. Post that, monthly refresher trainings will be undertaken, especially for the workers. Other training will be identified and implemented during the Project lifecycle as per the need assessment, as part of mitigation measure and also capacity building of the staffs.

An environmental and social management training program will be conducted to ensure effective implementation of the management and control measures during construction and operation of the Project. The training program will ensure that all concerned members of the team understand the following aspects:

- Purpose of action plan for the Project activities;

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- Requirements of the specific Action Plans;
- Understanding of the sensitive environmental and social features within and surrounding the Project areas;
- Aware of the potential risks from the Project activities.

In case of contractors having sufficiently well-developed standards on EHS management, the training can be sub-let to the same for their respective employees and KMRL will monitor the completion and sufficiency status of these programs. In case of subcontractors, the training and capacity building will be done by the KMRL HSE team member with site responsibilities, along with the contractor's EHS manager to ensure such trainings of the contracted staffs either directly or through trainers of KMRL , Subsequently the responsibility can be passed on to the sub-contractors for all future training programs.

8.7 Environment and Social Management Plan and Procedures

At the project level, KMRL needs to develop and implement following plans for management of environmental and social aspects of the project during construction and operation phase:

- Environment and Social Management Plan
- Waste Management Plan
- Storm Water Management Plan
- Occupational Health and safety Plan
- Community health and Safety plan
- Traffic Management Plan
- Environmental and Social Monitoring Plan
- Emergency Preparedness and Response Plan
- Stakeholder Engagement Plan
- Grievance Redressal Mechanism
- Budgetary provisions for ESMP Implementation

8.7.1 Environment and Social Management Plan

8.7.1.1 ESMP during Construction Phase

Major environmental, social and biological aspects considered during the Construction phase are:

- Water resources (ground and surface water) and their quality
- Ambient Air and Noise quality
- Soil quality
- Noise levels
- Solid and hazardous waste generation
- Ecology and biodiversity
- Local Economy of the area

Detailed ESMP proposed during the construction phase is given in following sections.

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Table 8-1: ESMP during Construction Phase

S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact with Mitigation	Monitoring/ Training Requirements
1.	Permit Compliance	<p>Non-compliance to various Environmental Permits required and pertaining to the proposed Kochi Metro or any other legal Implications.</p>	Major	<p>Site has to obtain various Environmental Permits such as no-objection certificate (NOC) for abstraction of ground water under Environment protection Act -1986, in case groundwater is used through installation of groundwater abstraction well or bore well. Factory License under Factories Act, 1948, CTE/CTO for Muttom Depot, Stations, and any DG sets going beyond the prescribed limits as applicable, and other permits related to workers and living conditions.</p> <ul style="list-style-type: none"> KMRL to develop a formal ESMS in line with Asian Development Bank (ADB), IFC Sustainability Framework 2012, and other applicable laws and regulations pertaining to environment, health, safety, social and labour in India. KMRL needs to develop various E&S procedures as part of its ESMS and convert them into site specific procedures for implementation at the site level, For example, procedure on environmental aspects like water and wastewater, on social aspects like stakeholder engagement and grievance redressal, etc. 	Minor	<p>KMRL should ensure maintenance of Legal register and Periodic EHS audits should be conducted to verify permit requirements and associated compliances</p>
2.	ESMP Implementation	Inadequate implication of ESMP by Developer/Contractor on	Moderate	<ul style="list-style-type: none"> Social, Environment, Health and Safety Organization Chart shall be prepared at Corporate level and Site-specific level. Clear roles and responsibilities should be defined for all the EHS departments across the organization including corporate, project level and site level. KMRL needs to maintain an EHS compliance register which would access the compliance of the mitigation measures suggested in the EMP. KMRL to ensure procedures for ESMP monitoring and reporting (externally & internally) for its contract agreement and other performance markers, to 	Minor	

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
		<p>oversee the performance and implementation of ESMP;</p> <ul style="list-style-type: none"> The contractor shall follow all stipulated conditions for pollution control as suggested in ESMP and as per the regulatory requirements. KMRL needs to maintain an SHE manuals and various formats to track an access the performance of the EPC contractor and the effectiveness of their policies and procedures. Periodic third-party/external monitoring through audits and inspections should be undertaken to assess the EHS and labour management performance of the sites, including compliance status, implementation of the procedures developed as part of the ESMS and same should be documented and reported back to corporate. KMRL should Maintain minutes of the monthly EHS meetings along with an action plan to access the compliance of the action discussed as well as the performance of the action stipulated. A formal monitoring and review procedure should be established between Corporate and sites. KMRL to develop a Stakeholder engagement plan, including Identification and Communication system whereby, every person relevant to the project is recognized as a stakeholder e.g. travellers along the metro alignment, visitors at religious structures on the metro alignment. There is a need to develop a medium to have communication with these stakeholders. KMRL needs to set up a formal grievance redress system for the third-party workers and for the external community. 				
3.	Land acquisition	Identification of landless, marginal and small land holding families among the project affected people.	Medium	The ongoing SIA to identify all who became landless or had marginal or small land holding post acquisition for the project. The same data to be shared with the land acquisition authorities in order to offer appropriate	Low	<ul style="list-style-type: none"> Review of the SIA report by KMRL;

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
4.	Loss of livelihood	Workers who lost their livelihood due to acquisition of commercial structures, are excluded from being eligible for compensation due to lack of documentation to prove their employment for the last three years.	Medium	<ul style="list-style-type: none"> Project to identify any workers left out of compensation due to lack of documentation and include them among project affected. The newly identified workers should be compensated at the same rate as workers already considered eligible. All project affected persons are identified and considered for compensation and/or R&R whenever applicable against the nature and scale of their impacts. 	Low	<ul style="list-style-type: none"> Revisions in the number of projects affected persons, Compensation disbursement status and R&R beneficiaries; Annual Impact Evaluation exercise to assess outcomes of compensation and R&R on all project affected people.
5.	Vulnerable groups affected by project	Although SIAs for road widening and Vadakkekkotta stations have categorised vulnerable groups, they are not all identified/accounted for. Moreover, there are no measures designed at compensation or R&R stages to specifically cater to the vulnerabilities of these groups.	Medium	<ul style="list-style-type: none"> A detailed census survey of all project impacted entities to be done for all three stations in Phase IA and IB to ensure every vulnerable person impacted by the project is accounted for. The vulnerable groups to receive separate/additional provisions of compensation in order to improve their standards of living. These provisions may include employment in the project or additional livelihood allowance or capacity building for employability etc. This should align with the ADB standards. 	Low	<ul style="list-style-type: none"> Review of SIA report by KMRL; Revisions in the number of project affected persons, Compensation disbursement status and R&R beneficiaries; Annual Impact Evaluation exercise to assess outcomes of compensation and R&R on all project affected people.

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
6.	Tree Cutting	<ul style="list-style-type: none"> Total 1138 nos of trees fall in the area. As per DPR approx 106 trees may be cut (68 between Pettai to Tripunithura and Pettai) and 38 between Tripunithura and Pettai). Compensatory plantation will be undertaken in ratio of 1:12 as per policy of KMRL which is more than the requirement of State Forest Department. 	Moderate	<ul style="list-style-type: none"> Only the most obstructive trees and shrubs to be removed and conserving the existing ground cover of the area as much as possible. There shall be no clearing of vegetation cover of lands which are not directly under construction footprints. The site clearance for construction activities shall be restricted only to the minimal area required for the respective purposes. The route alignment and width of the ROW should not be changed. Transplantation and compensatory plantations should be done as per applicable norms. The species which are removed should be planted in their original proportions and should include species of shrubs, climbers, herbs, grasses and bamboos that are currently forming the natural vegetation in the region. A list of native trees could be referred for selection of species. All such plantations to be done as per applicable regulations. Stacking, transport and storage of the wood should be done as per the relevant norms. 	Moderate	Client to obtain all requisite permissions for tree cutting and transplantation and compensatory plantation regulations to be followed
7.	Ambient Air Quality	<ul style="list-style-type: none"> Construction activities include excavation, material handling and stockpiling, wind erosion of unpaved work areas, Batching plant operation, open burnings etc. Point Sources impacts caused by exhaust gases from Diesel Generator Exhaust gases from vehicles operating in the work premises. Also, vehicular emissions traffic jam due to congestion. 	Moderate	<ul style="list-style-type: none"> KMRL through its contractors ensure precautions to minimise dust from being deposited upon public roadways as a direct result of their operations. Precautions include removal of particulate matter from equipment before movement to paved streets or prompt removal of material from paved streets onto which such material has been dropped. Site should be barricaded till all the construction works are over and the construction machinery and material are removed from the site. At each construction site, KMRL shall ensure provision of storage facilities for dust generating materials and shall be closed containers/bins or wind protected shelters or mat covering or walled or any combination of the above to the satisfaction of the Employer. 	Minor	KMRL and its Contractor to abide by the control measures.

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
				<ul style="list-style-type: none"> All construction equipment should be washed clean of visible dirt/mud before exiting the construction sites. Any deposition of material on public streets by construction equipment should be removed by manual sweeping, or by deploying electro – mechanical devices. Client shall provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from work sites such as construction depots, batching plants and site locations. Wheel washing facilities shall be provided with efficient drainage, incorporating silt traps to prevent any excessive build-up of water. These facilities must include water re-circulation apparatus to minimise water consumption. At the wheel wash facility, water, dirt, gravel etc. shall be drained into precast trench drains with removable grated cover. This dirty water shall flow, through a piping, into solids separator and from there to oil separator before final discharge. Where wheel-washing facility is not possible, Client shall ensure manual cleaning of wheels by wire brushes. Client shall ensure that vehicles with an open load carrying area shall be covered with tarpaulin used for moving potentially dust-producing materials (or similar fabric during rainy season), have properly fitting side and tailboards. Materials having the potential to create dust shall not be loaded to a level higher than the side and tail boards and shall be carried in vehicles fitted with covers. Loading and unloading of raw materials should be carried out in the most optimum way to avoid fugitive emissions. During dry weather, dust control measures such as water sprinkling shall be used continuously especially on windy, dry day to prevent any dust from blowing. 		

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
				<p>During rains, the stockpile may be covered with tarpaulin or similar material to prevent run off.</p> <ul style="list-style-type: none"> Best practices such as halting of activity during sustained strong winds should be opted for. It shall be ensured that all stockpiles are covered, and storage areas provided with enclosures to minimize dust from open area source. Stock piling and storage of construction material will be oriented after considering the predominant wind direction. Stockpiles of sand and aggregate greater than 20 m³ for use in concrete manufacture shall be enclosed on three sides, with walls extending above the stockpile. Client shall stockpile material in the designated locations by Client with suitable slopes. Access to the site shall be regulated for entry of persons, material and machine. Areas within the site such as construction depots and batching plants, where there is a regular movement of vehicles shall have an approved hard surface that is kept clear of loose surface material. Construction Vehicles/machinery should be regularly serviced and maintained. Vehicles engaged for the project will be required to obtain "Pollution under Control" (PUC) certificates. The engines of all vehicles and plant on site are not left running unnecessarily. Low emission vehicles and plant fitted with Emission control devices shall be used. The vehicles which meet BS IV standard shall be used. Machineries shall be well maintained, with routine servicing. Low sulphur diesel only should be used as fuel in DG sets. DG sets should be provided with Sufficient stack height as per the CPCB norms. 		

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
				<ul style="list-style-type: none"> Exhaust emissions of construction equipment to be adhered to emission norms as set out by MoEF&CC/CPCB. Cease or phase down work if excess fugitive dust is observed, or there is any community grievance related to dust. Investigate the source of dust and ensure proper dust suppression. For construction workers at accommodations, only LPG should be provided as fuel. Burning of the wood or any other fuel or open burning of the waste should be prohibited at the site and the labour accommodation site 		

At Casting Yard:

- Dust collector shall be used to reduce the fugitive dust generation and minimize air pollution.
- Conveyer belts are a source from where particulate matter escapes during concrete production. To control the flying dust, conveyor Belts shall be covered with sheets.
- Batching plant sites shall be cleaned, and water sprayed to minimize dust emissions.
- Exhaust fans shall be installed inside the cement storage area and a duct shall be connected to a bucket of water. This ensures that dust gets mixed with water that preventing emission.
- Client shall erect hoardings/barricades securely around all construction work sites during the main construction activity, to contain dust within the site area and also to reduce air turbulence caused by passing traffic. The barricade shall be safely secured to the ground to prevent from toppling with minimum or no gap between the base of hoarding and ground surface.
- Client shall undertake baseline monitoring to establish background data of air quality and

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
8.	Soil Quality	<ul style="list-style-type: none"> Though being a liner project, limited land will be required for the project for pier erection. Soil pollution, erosion can happen if construction work is not planned properly. Soil pollution due to contamination from spillage or improper handling, storage or disposal of solid, Hazardous and wastewater. 	Moderate	<ul style="list-style-type: none"> A Muck disposal plan to be prepared and site identified to scientifically dispose off the muck stained with polymers. Disposal of the excavated muck and construction debris shall be done as per the debris disposal plan only Earth material generated during excavations should be used for backfilling at the site. Topsoil from sites should be conserved and restored after excavation is over. If required, excess earth material should be disposed of at designated locations with due permissions from concern regulatory bodies. Provide appropriate storage of topsoil in an isolated and covered area to prevent its loss during high wind and runoff. Re-vegetation to be done in the area after the completion of construction, in order to reduce the risk of soil erosion. Topsoil should be utilized the time of plantation. Periodic checking shall be carried out by the contractor to assess the effectiveness of stabilization measures. Construction debris to be reused in paving on site approach road to prevent dust generation due to vehicular movement. 	Minor	<ul style="list-style-type: none"> The contractor in accordance with KMRL to prepare a Muck disposal plan and adhere to it. Procedure to be developed for utilization of topsoil which may include isolated storage of topsoil and its utilization for cover the surface or for gardening; Records to be maintain for generation and utilization of topsoil. KMRL to conduct Periodic EHS audits to access the implementation on site;

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
9.	Surface and Ground Water Quality	<ul style="list-style-type: none"> Possibility of contaminated runoff from the site entering ground; Domestic water runoff from the portable toilets into the ground water can lead to degradation of water quality. 	Major	<ul style="list-style-type: none"> To prevent soil compaction in the adjoining lands beyond the project area, the movement of construction vehicles, machinery and equipment shall be restricted to the designated haulage route. Fuel, chemicals and lubricants should be stored on impervious surface area at the predefined storage location with secondary containment provision. The storage area should be provided with gentle slope to a corner and connected with a chamber to collect any spills. Spill control kits should be available for control of any accidental spillage of oil, fuel or chemicals . Domestic solid waste at construction labour camp should be segregated into biodegradable and non-biodegradable waste. The non- biodegradable and recyclable waste shall be sold off. Efforts shall be made that bio-degradable waste is composted through pit-composting/bin-composting. All efforts should be made to minimize the hazardous waste generation. Unavoidable hazardous waste shall be managed as per Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016. Allow only covered transportation of topsoil within project site. Areas to be used temporarily shall for establishing casting yards, workshops, storage, labour camps shall be restored back to the original conditions. 	Moderate	<ul style="list-style-type: none"> Regular monitoring of storm water drains to check any contamination into drains; Regular monitoring of wastewater drains, septic tank and soak pit to check any waste findings its way to surface and ground water;

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
	<ul style="list-style-type: none"> Contamination from spillage or improper handling, storage or disposal of solid, Hazardous and wastewater. Project alignment will pass through Chembakkara canal at Tripunithura station area. As informed by KMRL and its EPC contractor, the surface water drain would be retained, and culvert would be widened to avoid the diversion of natural flowing path of water. For the proposed project the main concerns being the Chembakkara Canal and Canal at the proposed termination point of the metro at Tripunithura station. 			<ul style="list-style-type: none"> pollution. This will be complied in accordance with relevant legislative requirements. Construction of dedicated storm water drains for reduction of any contamination to runoff due to project activities. Storm water from construction depots and batching plants shall be discharged into storm drains via adequately designed sand/silt removal facilities such as sand traps silt traps or sediment basins. Discharges from concrete works will be high in suspended solids and pH. These washings shall be settled in a sedimentation pit (treatment to reduce pH), before Storm water is drained out. Sedimentation tanks or other acceptable measures, of sufficient capacity to trap silt-laden water before discharge into the outlet drain shall be provided. The system should be flexible and be able to handle multiple inputs from a variety of sources. Storm water drains shall be designed considering natural topography to avoid any obstruction to natural flow and final outlet shall be connected to maintain natural flow of water. 		<ul style="list-style-type: none"> Regular monitoring or inspection of fuel storage area, fuel loading/unloading area and hazardous waste storage area for any spillages or leakages into storage areas

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
				<p>wastewater drainage system shall be provided to drain wastewater into the sewerage system.</p> <ul style="list-style-type: none"> Domestic wastewater from site offices and labour camps shall be treated on Site septic tanks and soak pits as per the specifications in IS 2470:1995 (Part I and Part II); Oil separator/interceptors shall be provided at Batching Plant and location in construction depot for vehicle maintenance to prevent the release of oils and grease into the drainage system. These shall be cleaned on a regular basis. A spill prevention and control Procedure shall be prepared to identify project components such as storage areas, storage tanks that could allow discharge of oil/grease or hazardous materials to the drainage system or ultimately in any water body during spillage. The procedure shall include measures to contain and mitigate transportation of oil, grease or hazardous materials to the drainage system or any water body. All equipment operators, drivers and workers shall be provided with training in immediate response for spill containment and eventual clean-up. Emergency response procedures and reporting shall be made readily available by the contractor in simple and local language. Silt removal facilities, channels and manholes shall be maintained, and the deposited silt and grit shall be removed regularly, to ensure that these facilities are functioning properly at all times. For the purpose of preventing soil erosion, temporarily exposed slope surfaces shall be covered e.g. by tarpaulin, and temporary access roads shall be protected by crushed stone or gravel, as excavation proceeds. Arrangement shall always be in place to ensure that adequate surface protection 		

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
				<p>measures can be safely carried out well before the arrival of rains.</p> <ul style="list-style-type: none"> Measures shall be taken to minimize the ingress of rainwater into trenches. During rainy season, rainwater pumped out from trenches or foundation excavation shall be discharged into storm drains via silt removal facilities. Manholes shall always be adequately covered and temporarily sealed so as to prevent silt, construction materials debris from getting into the drainage system, and to prevent storm run-off from getting into sewers. Discharge of surface run-off into sewers shall always be prevented in order not to unduly overload the sewerage system. Surface run-off shall be segregated from the concrete batching plant and casting yard area as much as possible and diverted to the storm water drainage system. Surface run-off contaminated by materials in a concrete batching plant or casting yard shall be adequately treated before disposal into storm water drains. Site drainage, including surface runoff and dewatering effluents, shall be discharged to sewers where possible and relevant permissions will be obtained from the sewerage or statutory undertaker. Discharge to watercourses will only be permitted where discharge consent or other relevant approval has been obtained. Silt fencing should be undertaken near the Chembakkara canal as well as the canal near the termination point at Tripunithura station to prevent flow of silt/debris in canal. Mitigation measures need to be strengthened to protect the Chembakkara canal from contamination. Protection measures for works in or adjacent to watercourses shall be provided in accordance with appropriate requirements. The used materials in the 		

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
				<ul style="list-style-type: none"> permanent or temporary works that could pollute groundwater shall be avoided. All reasonably practicable measures shall be taken to prevent the deposition of silt or other material in, and the pollution by sediment of, any existing watercourse, canal, lake, reservoir, borehole, aquifer or catchment area, arising from work operations. All solid wastes such as construction debris, used or waste oil, paint cans, etc. will be stored on impervious surface in secure location to avoid soil and groundwater contamination; Loading and unloading protocols should be prepared and followed for diesel oil and used oil; Any containers of contaminating substances on site shall be leak proof and kept in a safe and secure building or compound from which they cannot leak, spill or be open to vandalism. Only construction equipment and vehicles free of all oil/fuel leaks shall be permitted on site. Drip trays shall be placed below static mechanical plant. All wash down of vehicles and equipment shall take place in designated areas and wash water will be prevented from passing untreated into watercourses. No lubricants, oils, solvents or paint products shall be allowed to discharge into water courses, either by direct discharge, or as contaminants carried in surface water runoff from the construction site. Storage areas should have adequate ventilation and be covered to prevent rain entering. All refuelling, oiling and greasing shall take place above drip trays or on an impermeable surface which provides protection to underground strata and watercourses and away from drains. Periodic monitoring shall be carried out to ensure that the wastewater is not finding its way into surface and groundwater; 		

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10.	Impact on Water Availability	Depletion on Ground and Surface water resources due to project water demand	Moderate	<ul style="list-style-type: none"> The contractor shall arrange for water required for construction in such a way that the water availability and supply to nearby communities remain unaffected. Water required for domestic and construction use should be taken from sources which have valid permission / permits for the same. In case of use of ground water, appropriate permission from Central Ground Water Board should be obtained for the same. Using curing agents for carrying out curing. If water is used for curing, then low flow sprinklers should be used for curing purpose, curing should be carried out during early morning & evening to minimize evaporation, concrete structures should be covered with gunny bags after curing is done to conserve the moisture. Any water obtained during dewatering shall either be re-used for construction purpose or recharge to the ground water at suitable aquifer levels. If reuse or groundwater recharge is not possible, then the contractor shall discharge water obtained from dewatering to the nearby drainage system with necessary permissions. Any effluent generated should be pre-treated and then reused or disposed as per relevant regulations. No vehicles or equipment should be parked, refuelled or repaired near water bodies. Temporary paved areas should be constructed to be used while refuelling the machineries 	Minor	<ul style="list-style-type: none"> KMRL and its contractors should ensure Water Consumption Records are maintained on daily basis; KMRL and its contractors should ensure Water recycling and reuse plan is prepared and implemented on yearly basis. KMRL to conduct Periodic EHS audits to access the implementation on site ; Rainwater harvesting/artificial recharge structures shall be provided; wherever feasible. Conservation of water to be undertaken along the alignment and ancillary facilities and if possible, recycling and reuse of water to be taken utilising every opportunity. Restoration plan to accommodate the loss of groundwater to be undertaken.

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10.	Noise and vibration from construction equipment, construction activities such as, earthwork excavation, concreting, viaduct construction and removal of spoil and movement of construction vehicles and delivery vehicles traveling to and from the construction and disposal sites.	<ul style="list-style-type: none"> Low flow taps shall be provided in toilets and kitchen and all water storage tanks should be covered to minimize loss due to evaporation Regular inspection of the water storage structures and pipelines to detect leakages. Detected leakages should be immediately repaired to minimize water loss Run-off from curing should be collected through drains into Workers should be educated to use water wisely and do not leave the taps open without use. Written notice should be displayed near the water taps for saving water & closing the taps. 	Medium	<ul style="list-style-type: none"> Temporary noise barriers will be used to reduce noise levels where appropriate and practicable. Such measures can be particularly appropriate for stationary or near-stationary plant such as pneumatic breakers, piling rigs and compressors. For existing diesel generator sets, the noise from the DG set shall be controlled by providing an acoustic enclosure or acoustic treatment of the room for DG sets. Such acoustic enclosures/ acoustically treated rooms shall be designed for minimum 25 dB (A) insertion loss or for meeting the ambient noise standards. 	Medium	<ul style="list-style-type: none"> KMRL along with its contractors should ensure periodic monitoring of noise level should is conducted and compared with the ambient noise standard. It should also be made sure that the levels do not exceeded the national ambient air quality standard (NAAQS) level; KMRL along with its contractors should ensure Training of workers along with handlers of construction equipment with mitigations of reduction techniques of noise pollution. KMRL to conduct Periodic EHS audits to access the implementation onsite ;
11.	Noise and Vibration Level	<ul style="list-style-type: none"> Pile driving or pavement breaking. Noise and vibration caused due to drilling for construction of piers and retrofitting of precast along the alignment. The dominant source of noise and vibration from most construction equipment is the engine, usually a diesel, without sufficient muffling. 	Major	<ul style="list-style-type: none"> Minimize the use of impact devices, such as jackhammers, and pavement breakers. Where possible, use concrete crushers or pavement saws for tasks such as concrete deck removal and retaining wall demolition. Equip noise producing equipment such as jackhammers and pavement breakers with acoustically attenuating shields or shrouds recommended by the manufacturers thereof, to meet relevant noise limitations. Pneumatic impact tools and equipment used at the construction site shall have intake and exhaust 	Moderate	

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				<ul style="list-style-type: none"> mufflers recommended by the manufacturers thereof, to meet relevant noise limitations. Provide mufflers or shield paneling for other equipment, including internal combustion engines, recommended by manufacturers thereof. Use construction equipment manufactured or modified to dampen noise and vibration emissions, such as: <ul style="list-style-type: none"> - Use electric instead of diesel-powered equipment. - Use hydraulic tools instead of pneumatic impact tools. Maximize physical separation between noise generators and noise receptors. Separation includes following measures: <ul style="list-style-type: none"> - Provide enclosures for stationary items of equipment and barriers around particularly noisy areas on site. - Locating stationary equipment so as to minimize noise and vibration impact on community. Client shall configure the construction site in a manner that keeps noisier equipment and activities as far as possible from noise sensitive locations and nearby buildings. Plant and equipment known to emit noise strongly in one direction should be oriented in a direction away from noise sensitive receptor. Reduce the number of plant and equipment operating simultaneously in critical areas close to noise sensitive receptors. Client shall schedule truck loading, unloading, and hauling operations so as to minimize noise impact 		

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			near noise sensitive locations and surrounding communities.	<ul style="list-style-type: none"> Equipment and plant shall not to be kept idling when not in use. Client shall maintain equipment such that parts of vehicles and loads are secure against vibrations and rattling. Grading of surfaced irregularities on construction sites to prevent the generation of impact noise and ground vibrations by passing vehicles. Schedule work to avoid simultaneous activities that both generate high noise levels. If back-up alarms are used on construction equipment, their noise emission level near noise sensitive receptors such as residences, schools, hospitals and similar areas where quiet is essential, shall be regulated, especially at night-time. Client shall have truck routes for muck disposal so that noise from heavy-duty trucks will have minimal impact on sensitive land uses (e.g., residential) and conduct truck loading, unloading and hauling operations in a manner such that noise and vibration are kept to a minimum and route construction equipment and vehicles carrying soil, concrete or other materials over streets and routes that will cause least disturbance to residents in vicinity of work and avoid operating truck on streets that pass by schools during school hours. The maximum permissible sound pressure level for new generator sets (upto 1000 KVA) run on diesel, shall be 75 dB(A) at one metre from the enclosure surface. For existing diesel generator sets, the noise from the DG set shall be controlled by providing an acoustic enclosure or acoustic treatment of the room for DG sets. Such acoustic enclosures/ acoustically treated rooms shall be so designed for minimum 25 dB(A) insertion loss or for meeting the ambient noise standards, whichever is on higher side. 		

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12.	Solid and Hazardous waste	<ul style="list-style-type: none"> • Waste generated during project construction phase will be from 	Moderate	<ul style="list-style-type: none"> Mobile noise sources such as cranes, earth moving equipment and HGVs shall be routed in such a way that there is minimum disturbance to receptors. Contractor shall instruct their safety officers to arrange for inherently quiet construction equipment and machines to maintain the noise level to minimum. Only manual construction activities shall be carried out during night-time (i.e. no use of machinery). The hours of operation for specified pieces of equipment or operations, especially mobile sources operating through community areas should be limited. All loud and sudden noises will be avoided wherever possible and fixed noise sources shall be located at least 50 m away from the site boundary. Rubber padding/noise isolators will be used for construction equipment or machinery. The personnel involved in high noise generating activities shall be provided with personal protective devices to minimize their exposure to high noise levels. Construction vehicles and machinery will be well maintained and not kept idling when not in use. Noise monitoring shall be carried out at noise sensitive receptor locations within 200 feet of the construction site once each week and after a change in construction activity. Construction noise measurements shall coincide with daytime and night-time periods of maximum noise generating construction activities. In case of complaints of uncomfortable noise received from the inhabitants of nearby settlements through Grievance Redressal Mechanism (GRM) there should be considered possibility of putting noise barriers near to the receptor. 	Minor	<ul style="list-style-type: none"> • KMRL to ensure the Waste Management plan
				<ul style="list-style-type: none"> All wastes generated at project site and labour camps will be segregated at source. Different waste collection bin should be provided for different types of 		

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	<p>construction area and labour camp</p> <ul style="list-style-type: none"> Unacceptable solid waste disposal, open dumping of solid waste and poor sanitation facilities lead to pollution of surrounding environment, contamination of water bodies and increase adverse impact to the aquatic; terrestrial lives and general public inhabited in the area. Poor storage and disposal of hazardous waste would be detrimental to the water bodies and soil quality. 	<p>waste. A Waste management plans should be developed which is site specific and includes the method of end disposal of the waste.</p> <ul style="list-style-type: none"> Municipal solid waste should be segregated, stored and disposed as per Solid Waste Management Rules, 2016. Bins for storage of bio-degradable wastes should be painted green, those for storage of recyclable wastes shall be white and those for storage of other wastes shall be black. Efforts shall be made that bio-degradable waste is composted through pit-composting/bin-composting. Domestic and construction waste like recyclables viz. paper, plastic, glass, scrap metal waste etc. will be properly segregated and stored in designated waste bins/containers and periodically sold to local recyclers. Non-biodegradable and non-saleable waste shall be disposed of with heap of local municipal waste disposal system. All construction and demolition waste should be handled as per Construction and Demolition Waste Management Rules, 2016. Other waste (such as solid waste) does not get mixed with construction and demolition waste and should be stored and disposed separately. The construction and demolition waste should be kept within the project area or get the waste deposited at collection centre so made by the local body or handover it to the authorised processing facilities of construction and demolition waste. It should be ensured that there is no littering or deposition of construction and demolition waste so as to prevent obstruction to the traffic or the public or drains. The contractor shall identify local construction waste disposal site in congruence with local authority to 				

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				<p>dispose any construction and demolition waste generated.</p> <ul style="list-style-type: none"> All the hazardous waste should be handled and disposed as per the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 (as amended). Register of all hazardous materials used and accompanying material safety data sheet (MSDS) should be maintained. The contractor shall ensure that hazardous waste is stored separately with spill control kit on impervious surface along with secondary containment with 110% capacity of the waste stored. Spilled material should be tracked and accounted for. Hazardous waste should be disposed to State Pollution control Board authorised agency only. Packaging, labelling, and transport of hazardous and other waste should to be done as per the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016. Training to be provided to the workers on how to segregate, store, handle and dispose waste. They should also be apprised on the MSDS of each chemicals and other hazardous wastes. The hazardous materials, if stored at the construction site like cylinders, petroleum, spirit, diesel, lubricating oil, paints etc. should be stored as per the statutory provisions of Manufactures, Storage and Import of Hazardous Chemicals Rules, 1989. After completion of the construction; the contractor shall ensure the site and labour camps areas are cleaned, all waste disposed as per relevant regulations and handled over to client. Domestic and construction waste like recyclables viz. paper, plastic, glass, scrap metal waste etc. will be properly segregated and stored in designated waste 		

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13.	Traffic and Transport	<ul style="list-style-type: none"> Community Health and Safety Traffic related accidents and injuries; Increased pollution 	Moderate	<ul style="list-style-type: none"> Only trained drivers with valid license shall be recruited by Contractor for transfer of material; Training program for all the drivers, regarding awareness about road safety and adopting best transport and traffic safety procedures shall be provided before initiation of the decommissioning activities; Mitigation measures such as emphasizing on safety amongst drivers, adopting limits for trip duration and arranging driver roster to avoid overtiredness and avoiding dangerous routes and times of day to reduce risk of accident shall also be implemented; Regular maintenance of vehicles and use of manufacturer approved parts should be adopted to minimize potentially serious accidents caused by equipment malfunction or premature failure; The stakeholders shall be made aware about the schedule prior to the movement of trucks and transportation in the Project area. 	Minor	<ul style="list-style-type: none"> KMRL in accordance with its contractors should Develop Traffic management plan and monitor its implementation on site; Maintain records of driving licenses; Training to drivers; Grievance Redressal of any complaint received related to traffic

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14.	Occupational Health and Safety	<ul style="list-style-type: none"> Material handling and storage Possible injuries associated during civil work of drilling for pier construction, placing the precast viaducts etc. Other occupational hazards Accidents during cutting, chipping and piling Physical injuries when workers involved in loading/unloading activities and don't adhere to proper ergonomics discipline. Trip and fall hazards Violation of the privacy and dignity of women involved in the work force. Other occupational hazards Diseases due to unhygienic condition 	Moderate	<ul style="list-style-type: none"> KMRL to ensure that the diversion/detour is always maintained in running condition, particularly during the monsoon to avoid disruption to traffic flow. The temporary traffic detours will be kept free of dust by sprinkling of water three times a day and as required under specific conditions (depending on weather conditions, construction in the settlement areas and volume of traffic). LED lights/Photoluminescent signs to be provided on the barricades to guide the traffic at night. KMRL to provide, erect and maintain all traffic safety measures during construction such barricades, including signs, markings, flags, lights and flagmen as proposed in the Traffic Control Plan. 	<ul style="list-style-type: none"> KMRL has framed the SHE policy and it is essential for all contractors to follow the SHE Policy. KMRL need to develop and implement a Health and Safety (H&S) plan to follow throughout the construction phase. Also, ensure that the H&S plan is provided to the EPC contractor for implementation at the site; Provide occupation health and safety orientation training to all employees and workers consisting of basic hazard awareness, site-specific hazards, safe working practices, and emergency procedures; The contractors will be committed to ensure all Health and Safety measures are in place to prevent accidents and reduce the consequences of non-conformance events; The contractors will provide training, awareness and supervision to ensure all of its construction workers comply with the OHS procedures; The contractor will provide appropriate resources i.e. PPE to workers on Site; 	<ul style="list-style-type: none"> Minor • KMRL to prepare a Health and Safety policy and based on the policy prepare H&S Plan that would be incorporated in Contractor agreements. • Development of site-specific Hazard and operability study along with Emergency Preparedness Plan • Annual training calendar to be prepared and conducted which would cover all the H&S related trainings mentioned in the EHS manuals. • Incident, accident and near miss records to be maintained. • Contractors to produce Monthly EHS reports to KMRL to access the

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				<ul style="list-style-type: none"> An emergency response procedure and infrastructure will be available on Site to ensure provision of first aid for personnel in case of emergency. All the workers should be made aware of the possible occupational risks/hazards by the way of an OHS training/awareness program An accident and incident reporting, and monitoring record should be maintained. It should also mention near misses, which would also include training for better learnings with the near miss incidents. All the lifting equipment should be properly examined and tested prior usage. All relevant information should be known about the load, method of slinging and attachment points Person involved for lifting and installation works and those working in heights should be properly trained for the work assigned Safety officers & supervisors should be present all the time at site during execution of the work, lying of foundations, piers, piers cap, slabs etc. When lifting large loads, ensure weather conditions are favourable for the task. Heavy lifting equipment typically has safe operating parameters included in its operating manual and these parameters should not be exceeded at any time Where possible, exclusion zones should be established and maintained in order to prevent any unauthorized access to lifting areas Only trained labour should be engaged for working at height. Gas cylinders should be kept up right on a custom build stand or trolley. Metal cap should be kept in place to protect the valve when the cylinder is not connected for use. All gas cylinders should be fixed with pressure regulator and dial gauges. Non-return valve and flashback arresters shall be fixed at both end of cylinder and torch. 		effectiveness of the mitigation measures.

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				<ul style="list-style-type: none"> Firefighting facility should be available at the site. CO2 based fire extinguishers should be provided at the gas cutting/welding area and foam based should be provided at fuel storage area. Fire extinguishers should be provided at all areas as per suitability defined in IS: 2190. Fire evacuation plan should be provided at each work area. Fire evacuation plan should be explained to all the workers, staff & visitors. Fire exit signs should be provided at all the areas and these signs should be LED lit. First aid trained personnel should be available at the site and tie ups with the nearby hospital should be made so as emergency situation can be handled. Ambulance or safety motorized vehicle should be available at the site 24 X 7. Labour should be given PEP talks on daily basis, training for handling heavy machinery & equipment, for working on heights, handling the construction material, training on general safety etc. on monthly basis. Further mock drills should be arranged for workers for firefighting, earthquake, rescue a person for a person stuck at height etc. Emergency assembly area should be provided at the site and the location should be communicated to all. All worker should collect at that location during the emergency Emergency contact nos. (SHE head, SHE officers, Traffic managers, First Aid Personnel, Ambulance, Fire Brigade, Hospital) should be displayed at the site Safety guidelines, safety policy, safety slogans should be displayed at the site in English and local language of the area Proper hygienic and scientific sanitation facilities need to be provided for all the labourer's working in the site. 		

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15.	Community Health and Safety	<ul style="list-style-type: none"> Risk of Accidents and other mishaps due to construction work. Accessibility disruption of stakeholders. 	Moderate	<ul style="list-style-type: none"> Exclusive arrangements for women to ensure the privacy and dignity of all individuals should be arranged by the contractors and overseen by KMRL. GRM procedures to be developed for all labours. The grievances should be resolved on emergency bases and without any biases. Contractor should inform the labour about Emergency Preparedness Plan (EMP) and communication system to be followed during emergency situation. Suggested environment management plan should be implemented to minimize the pollution from the project and associated social issues All construction site, activity area, casting yards, fuel storage area, workshop area etc should be barricaded and the entry should be restricted to authorized personnel only. ID cards should be issued to all the authorized personnel including the workers, labour, employee, staff, inspectors & visitors No excavated area should be left open without barricading. LED lights should be provided on the barricading to guide the traffic in night. Traffic marshals should be deputed in the area requiring minor & major traffic diversion to guide the traffic about the diversions. Notices should be displayed on LED lit boards to caution public about the work in progress, speed limits to be kept, sharp curves, diversions etc. Traffic diversion and management plan shall be prepared prior undertaking diversion in consultation with RTO and same shall be shared with the public through appropriate media including newspaper (local & English language), National television and through radio at least 1-week prior diversion KMRL to provide safe and convenient passage for vehicles, pedestrians and general public to and from roadsides and property accesses, providing temporary connecting road. 	Minor	<ul style="list-style-type: none"> KMRL should take all steps possible to ensure that least discomfort is caused to the community living adjacent to the construction work. All KMRL and its contractor should be trained to work with peace and harmony with the community.

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				<ul style="list-style-type: none"> KMRL will also ensure that the existing accesses will not be undertaken without providing adequate provisions. Alternate arrangement for the resource shall be arranged for community prior dismantling/disturbing the utilities (water supply pipeline, sewerage line, drainage line, electricity lines, etc.) which will be affected due to project development Public shall be pre-informed through appropriate media for preparedness in case of disturbance of service which cannot be shifted prior dismantling and some alternate arrangement shall be made for public KMRL will take care that the crossroads are constructed in such a sequence that construction work on the adjacent crossroads are taken up one after one so that traffic movement in any given area not get affected much. A grievance redressal system should be in place and communicated to the public to register their grievances, if any. Grievance redressal mechanism should be such that all the complainants should be registered irrespective of colour, caste, creed & position. All the registered complaints should be enacted within 15 days of registration. Consultation with the affected/grieved should be carried out by in charge of the grievance redressal cell. Registered grievance should be resolved completely within 1 month of registering the grievance. No public place like parks, footpaths, etc should be used for any purpose for project without any prior permission from concerned department and information to the affected public Where possible, exclusion zones should be established and maintained in order to prevent any unauthorized access to lifting areas Labour should be trained for on social behaviour and community interaction and should be cautioned for 		

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16.	Biodiversity and Ecosystem Services	<p>The project involves activities such as tree cutting, land levelling, movement of heavy machinery and vehicles, artificial illumination, bridge construction in river basin. All these activities are likely to impact floristic and faunal species, habitats and ecosystem services</p>	Moderate	<ul style="list-style-type: none"> Load carrying vehicle should move at slow speed only to prevent accidents like toppling over, collisions etc. Speeds should be designated for these vehicle as per the load and vehicle violating the rules shall be penalized Tree felling, clearing of vegetation and trimming of trees in accordance with the applicable regulations. Planting native trees/plants during the landscaping stage of a project can increase the biodiversity in an area. Project proponent shall not allow introduction of exotic species with known environmental setbacks. All work areas shall be smoothed and graded in a manner to conform to natural appearance of the landscape. Awareness program on Environment and Wildlife Conservation shall be provided to the work force. Restoration of any access roads not required beyond the construction phase Restriction of movement of vehicles and operation of heavy machinery to pre-designated routes Restriction of construction activities to daytime hours Avoidance of artificial illumination during night-time Avoidance or damping of construction noise and vibrations to the maximum extent possible Institution of efficient systems for containment and disposal of waste or spillage Prohibition of harvesting of water, fuelwood or wild foods (including fauna) by construction labour Use of seamed paving instead of contiguous concrete surfaces to reduce hindrance to rain-water percolation 	<p>Moderate</p> <ul style="list-style-type: none"> Trainings for site managers, construction contractors and construction labourers to sensitize towards biodiversity and ecosystem services conservation Preparation and implementation of a Biodiversity Conservation Plan 	

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
17.	Local employment generation	<ul style="list-style-type: none"> Insulation of all project-related electrical components to avoid electrocution risk to fauna The Contractor should ensure that all precautions to protect the workers from insect and pesto to reduce the risk to health. This includes the use of insecticides. 	High	<ul style="list-style-type: none"> KMRL to ensure preference to local workers in case of additional workforce requirements. KMRL through its contractors should ensure that labour is being adequately paid by contractors. Also ensure that wages are being paid as per the requirement of minimum wages act KMRL should conduct internal audits as when required to monitor the performance of contractor. KMRL through the contractor inform the labour about emergency preparedness plan and communication system to be followed during emergency KMRL through contractor should ensure that labour receive training on health and safety issues involved in the proposed project. 	Medium	<ul style="list-style-type: none"> Periodic EHS audits should be conducted to monitor the same Grievance Redressal mechanism should be followed and monitored Human Resources Department to maintain a ratio of migrant vis-à-vis local workers on quarterly basis for all contractors and subcontractors providing services and human resources for the project. Any new contractors engaged should be instructed to give preference to locals for employment and the contract agreements should mention a clause on local employment creation.
		Although some proportion of workforce including security personnel, traffic marshals and some of the contractors are hired locally; majority of the workforce is migrated from other states of India.	Moderate	<ul style="list-style-type: none"> KMRL should follow all relevant provisions of the Building and the other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 for construction and maintenance of labour camp. KMRL will maintain necessary living accommodation and ancillary facilities in functional and hygienic manner. KMRL will construct and maintain all labour accommodation in such a fashion that uncontaminated water is available for drinking, cooking and washing. KMRL will also provide potable water facilities within the precincts of every workplace in an accessible place, as per standards set by the Building and other 	Minor	

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				<p>Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996.</p> <p>KMRL should ensure the following:</p> <ul style="list-style-type: none"> - Supply of sufficient quantity of potable water (as per IS) in every workplace/labour camp site at suitable and easily accessible places and regular maintenance of such facilities. - If any water storage tank is provided that will be kept such that the bottom of the tank at least 1meter above the surrounding ground level. - If water is drawn from any existing well, which is within 30meters proximity of any toilet, drain or other source of pollution, the well will be disinfected before water is used for drinking. - All such wells will be entirely covered and provided with a trap door, which will be dust proof and waterproof. - A reliable pump will be fitted to each covered well. The trap door will be kept locked and opened only for cleaning or inspection, which will be done at least once in a month. - Testing of water will be done every month as per parameters prescribed in IS 10500-1991. - Separate toilets/bathrooms, wherever required, screened from those from men (marked in vernacular) are to be provided for women - Sewage system for the camp should be designed, built and operated in such a fashion that no health hazards occurs and no pollution to the air, ground water or adjacent water courses take place - Adequate water supply is to be provided in all toilets and urinals 		<ul style="list-style-type: none"> • KMRL to set up internal audit procedure for contractual workers and staff which is inclusive of:
18.	Labour influx	<ul style="list-style-type: none"> • Increased pressure on local health-care services which may lead to inadequate facilities or services available for either 	Medium	<ul style="list-style-type: none"> • All workers engaged for project work to be covered under ESIC or Workmen Compensation for general illnesses, which helps in treating minor illnesses timely to avoid immune deficiencies; 	Low	

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19.	workers or locals at the time of COVID-19 or related emergencies. The social impact associated with the labour accommodation or setting up labour camp (onsite) is anticipated in the form of conflict between labours and contractors /community, if not managed properly.	<ul style="list-style-type: none"> All workers to be tested COVID-negative through an RT-PCR test from an ICMR approved laboratory before joining work; Any worker showing symptoms of COVID-19 during the period of work at the project, the same test should be undertaken from ICMR approved labs at contractor's expense; Any worker required to be quarantined during the period of work, should receive full payment for the period along with other due entitlements e.g. PF. KMRL to ensure no conflict with community due to different cultural behaviour and sharing of local resources occurs between the labours and residents. GRM procedures to be developed and made aware to all labours and community. The grievances should be resolved on emergency bases and without any biases. 	Medium	<ul style="list-style-type: none"> • All workers to be tested COVID-negative through an RT-PCR test from an ICMR approved laboratory before joining work for the project, procedure followed in case of a worker shows symptoms of or is tested positive COVID-19. • The methods of audit should involve, meeting with all contractors as well as visit to sites and accommodation locations of workers for primary knowledge of the conditions. 	Low	<ul style="list-style-type: none"> • KMRL to develop a stakeholder engagement plan and Grievance redressal plan • KMRL to monitor the plans and procedures for indicators to measure the performance of these plans and procedures.
20.	Archaeologic al Property	Chance finds of any archaeological property.	Moderate	<ul style="list-style-type: none"> KMRL does not have in place a formal Stakeholder Engagement Plan and a Grievance Management Plan at present. For the extended construction period and smooth transitioning from construction to operations phase there is need to set up a formal engagement system between project proponent and its stakeholders. 	Minor	<ul style="list-style-type: none"> • KMRL will take reasonable precautions to prevent his workmen or any other persons from removing and damaging any Archaeological Property or thing. KMRL, its contractors, or any of its workers will, immediately upon discovery thereof and before removal acquaint the Independent Engineer of such discovery and carry out the instructions for dealing with the same, waiting which all work shall be stopped. • Trainings and awareness to site managers, construction contractors and construction labourers.

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
				<ul style="list-style-type: none"> KMRL will seek direction from the Archaeological Survey of India (ASI) if any suspected property is found. All fossils, coins, articles of value of antiquity, structures and other remains or archaeological interest discovered on the site shall be the property of the Government and shall be dealt with as per provisions of the relevant legislation. KMRL to develop a chance finding procedure for the project in consistency with regulatory requirement and best practices. 		

8.7.1.2 ESMP during Operation Phase

The environmental and social management plan proposed during the operation phase has been prepared considering the impacts this project may have on the surround environment and human beings' due operational activities. The major aspects covered during the operation phase are ambient air, solid and hazardous waste generation, wastewater management, ecology and biodiversity. Detailed ESMP proposed during the operation phase is given in Table 8-2

Table 8-2: ESMP during Operation Phase

S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
1.	Aesthetics and Visual	Visual and landscape impacts	Minor	<ul style="list-style-type: none"> Area under the viaduct and near the stations should be regularly monitored and no commercial establishments or slums should be allowed to come up. Colour of the viaducts and piers should be kept in such a way that they are aesthetically pleasing . Bills should not be allowed to be stuck on the piers and other structures. Regular cleaning of the stations, nearby areas and the areas under via duct should be carried out. Area under viaducts and additional land if available near stations and depots should be used for development of green area. 	Minor	KMRL to ensure periodic audits should be conducted to monitor the compliance.
2.	Air Quality		Minor	<ul style="list-style-type: none"> Positive Impacts are envisaged due to reduction in plying of private vehicles due to the usage of Metro. However, there could be impacts of emission from vehicle congestions along the alignment. Further there would be impacts due to emissions from DG sets used at stations and associated facilities. 	Minor	KMRL to ensure periodic audits should be conducted to monitor the compliance.

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
1.	Impact on Soil Quality	<ul style="list-style-type: none"> Contamination of land and soil; Impacts due to improper waste handling 	Minor	<ul style="list-style-type: none"> Roads in the station area should be properly maintained and sprinkled with water. Sufficient stack height needs to be provided to D.G. sets as per the CPCB norms. 		KMRL to ensure periodic checking of solid and hazardous waste storage areas, fuel storage areas, chemical storage areas for checking in spillage or leakages from these areas
2.	Impact on Water Body	<ul style="list-style-type: none"> Disturbance to soil from repair and maintenance activity will be limited and will ensure proper restoration of soil wherever excavation is undertaken. Waste generated should be properly collected and segregated at each station in twin bin system. Recyclable fraction of waste should be sold to authorized vendor periodically and non-recyclable/rejected version should be disposed on daily basis through local agencies in the area responsible for waste management Fuel, chemicals and lubricants should be stored on impervious surface area at the predefined storage location with secondary containment provision. The storage area should be provided with gentle slope to a corner and connected with a chamber to collect any spills. 	Minor	<ul style="list-style-type: none"> Spill control kits should be available for control of any accidental spillage of oil, fuel or chemicals Domestic solid waste at station and maintenance depot should be segregated into biodegradable and non-biodegradable waste. The non- biodegradable and recyclable waste shall be sold off. Efforts shall be made that bio-degradable waste is composted through pit-composting/bin-composting. All efforts should be made to minimize the hazardous waste generation. Unavoidable hazardous waste shall be managed as per Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016. Authorisation will be obtained from SPCB for generation of hazardous waste and disposal should be carried out through a SPCB authorized vendor. 		
3.	Impact on Air Quality	<ul style="list-style-type: none"> Contamination of land and soil; Impacts due to improper waste handling 	Minor			

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
4.	Impact of Noise Levels	Impacts caused due to the operation of Rolling stocks on tracks.	Moderate	<ul style="list-style-type: none"> Provision of GRP baffle on the via duct for elimination of noise transmission Provision of sound absorbing material in the supply duct and return grill of air conditioner Provision of anti-dumping floor and noise absorption material Low speed compressor, blower and air conditioner Mounting of under frame equipment and anti-vibration pad Smooth and gradual control of door Sealing design to reduce the aspiration of noise through the gap in the sliding doors and piping holes Provision of bolsters less type bogies having secondary air spring Ballast less track supported on two layers of rubber pads can be used to reduce track noise and ground vibrations In sensitive areas, track on floating slab can be used to reduce track noise and ground vibrations 	Minor	KMRL to ensure periodic audits should be conducted to monitor the compliance.

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
4.	Impact on Water Quality	The vibration generated from rail-wheel interaction will be greatly absorbed by the elastic fastening system proposed to be used. Resilient fasteners are used to fasten the rail to concrete track slabs or ballast less bed. A ballast mat consists of a rubber or other type of elastomer pad that is placed under the ballast can be used for reducing vibrations. The mat generally must be placed on a concrete base to be effective Other measures which can be taken to reduce vibrations are usage of resiliently supported ties in which concrete ties are supported by rubber pads Implement vehicle reconditioning programs, particularly when components such as suspension system, brakes, wheels, and slip-slide detectors will be involved. The regular regime of reconditioning helps not only mitigation of vibration but also in lower resultant defect generation. Noise barriers help in reduction of the noise level. Noise barriers can reduce the noise level from 6-15 dB (A). Noise barriers should be provided to minimize the noise levels along the sensitive locations. Noise barrier comprising of absorptive type metal panel and reflective type poly carbonate sheets can be located on edge of the viaducts to reduce the noise intensity to be generated due to metro movement. Height of these barriers can be kept 1.5-2.0 m above the top of rail. The barrier must be long enough to screen out a moving train along most of its visible path. Thus, length of the barrier shall be considered additional 1 m on both ends at proposed locations.	High	• Disposal of sewage through septic tank at stations and timely evacuation of the septic tanks should be carried out. • No area should be left excavated or open after any repair & maintenance works so as there will not be	Minor	• Periodic audits should be conducted to monitor the compliance. • KMRL should monitor that the water quality at the
5.	Impact on Water Quality	Impact on water quality due to contamination through improper handling of waste, or any kind of spillage of hazardous material.	Moderate	•		

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
6.	Water Availability	Depletion of water resources due to project water demand	Minor	<p>chance of sediments getting mixed with the rainfall run-off into a water body or ground water.</p> <ul style="list-style-type: none"> Proper storm water drainage system and rainwater harvesting pits should be provided to harvest the storm water and recharge the same into ground water aquifer system to augment the ground water level and reduce the run-off into the surface water bodies. Storm water drains and pits shall be cleared every year prior start of monsoon All wastes arising from the project should be disposed in an environmentally accepted manner. Any domestic wastewater e.g. sewage should be disposed of suitably with help of sewage treatment facility. Any effluent generated should be pre-treated and then reused or disposed as per relevant regulations. Period monitoring shall be done to check siltation and also to ensure that flow of water is maintained through cross drains and other channels to avoid their blockage/ choking. Side drain shall be constructed to guide the water to natural outfalls to maintain natural drainage pattern. Water quality monitoring for the same parameters, which were monitored during the baseline studies, shall be implemented by KMRL by hiring the services of the NABL accredited and MoEF&CC Notified laboratory. The Indian standards for drinking water IS 10500:2012 for surface and ground water sample shall be used for analysis of the fresh water quality. Similarly, general standards for discharge of environmental pollutants mentioned in schedule VI of Environmental Protection Act, 1986 shall be used for analysis of creek water quality. 	Minor	<ul style="list-style-type: none"> Maintaining water consumption records on daily basis;
				KMRL shall arrange for water required for operation in such a way that the water availability and supply to nearby communities remain unaffected.	Minor	<ul style="list-style-type: none"> Maintaining water consumption records on daily basis;

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
7.	Occupational Health and Safety of Workers	<ul style="list-style-type: none"> Electrocution Fire due to short-circuit Possible injuries associated with working at height during maintenance. Diseases due to unhygienic condition 	Moderate	<ul style="list-style-type: none"> All the staff should be given training for carrying out the work assigned keeping the safety as priority. Regular electrical safety training to workers with safety procedures and other safety requirements that pertain to their respective job assignments; Tests should be undertaken for workers working at heights prior joining. Work at height should be undertaken during daytime only. Induction training should be given to all the workers at the time of joining which should include awareness of the activities to be carried out by worker, tools involved, risks involved and personal protective equipment to be used 	Minor	<ul style="list-style-type: none"> KMRL to ensure Labour engaged for working at height should be trained. All the workers should be made aware of the possible occupational risks/hazards by the way of an OH&S training/awareness program An accident reporting, and monitoring record should be maintained GRM is properly maintained and followed on site. Contractor should inform the labour about Emergency Preparedness Plan (EMP) and

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
				<ul style="list-style-type: none"> Personal Protective Equipment (PPEs) e.g., shock resistant rubber gloves, shoes, other protective gear etc. should be provided to workers handling electricity and related components and monitored that they are used by the employees Periodic inspection of PPE should be done to ensure that they are in proper condition by keeping the records All the stations should be equipped with fire extinguishers and sand buckets at all strategic locations to deal with any incident of fire; Functioning of metro, stations, electrical equipment & network, DG sets etc should be audited and inspected by eligible third part on regular basis System of work permits should be issued in case any maintenance work is being undertaken at track, electrical wires, OHE, control room and any such area. LOTO system should be implemented to minimize the accidents Everyday PEP Talks should be taken up with the security & maintenance staff to communicate the major safety principle to be followed and kept in mind. Safety meetings should be held monthly to discuss the existing safety practices and measures for improvising the procedures Mock drills should be conducted to train staff for handling emergency situations Emergency preparedness & response plan prepared for the project should be followed Trainings should be conducted for drivers on regular basis to train them about the safety procedures and strictly following the rules Regular monitoring, servicing & maintenance of all the signalling, transmission and communication system to minimize the chances of accidents 		

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
8.	Community Health and Safety	Impacts on regular commuters during operation of Metro	Minor	<ul style="list-style-type: none"> • Accident, Incident and near miss records should be maintained. Accident reporting should be done within 1 day after accident and detailed root cause analysis should be carried out for each accident so as preventive measures can be taken to prevent any similar accidents in future. • Proper signage about the stations, entry, exit, fire exit, directions, safety messages, conservation of energy & water, non-spitting, non-littering, restricted entry etc should be provided at all the stations and inside the metro to make the passenger and staff about the risks involved and required safety measures to be taken • Adequate emergency exit should be provided in the metro and at station and the location of the same should be displayed at all the suitable locations. Along with the visual display, audio messages should also be communicated at the stations and in metro about the safety measures to be taken • Rumble strips should be provided on the roads in front of stations so as the speed of vehicle is regulated near station area and chances of accident is minimized • There should be arrangement for hygienic and scientific sanitation facilities at all stations. • Floors of stations and metros should be kept in pristine conditions with good housekeeping on daily basis. • Entry to the control rooms, firefighting rooms, DG area and other similar areas should be restricted for passengers and entry of such areas should be guarded • Elevators provided should be regularly maintained and checked for proper functioning • Maintenance of the metro and other equipment should be carried out regularly as per the approved maintenance schedule 	Minor	Periodic audits should be conducted to monitor the compliance.

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S. N.	Aspects	Impacts	Impact Intensity	Mitigation/ Control Measures	Impact Intensity with Mitigation	Monitoring/ Training Requirements
9.	Local employment generation	<ul style="list-style-type: none"> • Certified First aid trainer should be present at all the stations all the time • All the platforms should be properly guarded to ensure people board & deboard in queue and do not stand beyond the demarcated area • Dos and Don'ts during the natural calamity and accidents should be displayed at stations and in metro for passengers and staff so as they know what is to be done during and after emergency. • Emergency contact numbers should be displayed at the stations & in metro • Regular maintenance of the viaduct, piers, pier caps, OHE system should be done. Regular inspections should be carried out to detect any breakage, cracks or deformity • Proper guards/safety provision should be made along the railings of elevated metro stations. Entry beyond the certain points should be restricted for the passengers. 	Low	<ul style="list-style-type: none"> • KMRL to ensure good working conditions and terms of employment for persons employed for project during operations phase. • KMRL can conduct gender-sensitisation programs for women and transgenders that may be working in the facility management services from Kudumbashree. 	Medium	KMRL HR Manager to arrange for gender-sensitisation programs from credible organisations for the employees and workers engaged for the project, to ensure an inclusive and non-discriminatory environment at work.
10.	Traffic congestion	Reduction in congestion on metro alignment	Low	<ul style="list-style-type: none"> • Commencement of metro is highly likely to significantly reduce the road traffic by diversion of commuters to using metro for travel. 	Medium	

8.7.2 Waste Management Plan

Waste Generation:

All project generated wastes shall be managed and disposed of in a manner to prevent potential impacts on the environment and risks to human health. A Waste Management Plan (WMP) for the proposed project has been proposed. The Construction Waste Management Plan (CWMP) shall ensure all waste arising from the construction works are managed in a sustainable manner, maximizing the opportunities to reduce, reuse and recycle waste materials. The Construction Waste Management Plan shall contain:

- Classification of all wastes
- measures to minimise waste generation
- opportunities for re-use or recycling
- provision for the segregation of waste streams on site that are clearly Labelled
- Recording of proposed carriers and the terms of their respective licenses.
- Licensing requirements for disposal sites.

The plan shall be applicable to the KMRL and O&M Contractor along with all subcontractors engaged by KMRL for the proposed project. The elements of the plan will be directly implemented by the O&M staff deployed on site while overall management and responsibility will lie with KMRL.

8.7.2.1 Waste classification

The waste generated from the project activity shall be classified as hazardous and non-hazardous waste.

Hazardous Substance:

Any waste which by reason of characteristics such as physical, chemical, biological, reactive, toxic, flammable, explosive or corrosive, causes danger or is likely to cause danger to health or environment, whether alone or in contact with other wastes or substances e.g. oil, grease, Paints etc. Hazardous waste would mainly arise from the maintenance of equipment such as:

- Used Engine Oils, Hydraulic fluids and waste fuel;
- Cleaning fluids from mechanical machinery;
- Scrap batteries and
- Spent solvents/ solutions

Non-hazardous Substance:

The waste will generate from construction activities like land excavation, site formation, civil/building construction, roadwork, renovation or demolition activities etc. The types of waste generated under this category are food waste, paper & cardboard & wood construction rubble / debris, Vegetation and Topsoil etc. Other categories of waste will be produced daily and comprise of the following:

- Scrap metal;
- Soil waste;
- Food waste from kitchen premises of labour accommodation;
- Construction debris; and

8.7.2.2 Waste Mitigation Plan

Client shall carefully design and plan good site management which can minimize waste of materials such as concrete mortars and cement grouts. Client shall ensure regular maintenance and cleaning of the waste storage areas.

Construction activities are expected to generate a variety of waste such as:

- General refuse

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- Construction Waste including waste from excavated material
- Chemical waste and
- Hazardous waste
- Biomedical waste

General Refuse:

- Each worksite would generate general refuse including paper and food waste. There is likely to be a concentration of such waste at batching plants on major worksite. The storage of general refuse has the potential to give rise to negative environmental impacts.
- Handling and disposal of general refuse shall cope with the peak construction workforce during the construction period. Provided the refuse is stored and transported in accordance with good practice and disposed to authorized agency approved by local Municipal Corporation so that the negative environmental impacts would be minimal.
- General refuse shall be stored in enclosed bins or units separate from construction and chemical wastes. An authorized waste collector shall be employed by us to remove general refuse from the site, on a daily basis to minimise odour, pest and litter impacts.
- Office waste can be reduced through recycling of paper if volumes are large enough to warrant collection.

Construction Waste

- Construction Waste would mainly arise from the project construction activities and from the demolition of existing structures where necessitated. It includes unwanted materials generated during construction, rejected structures and materials, materials that have been over-ordered and materials, which have been used and discarded such as:
- Material and equipment wrapping packaging material
- Unusable/surplus concrete/grouting mixes
- Damaged/contaminated/surplus construction materials; and
- Wood from formwork and false work.
- Also, demolition of buildings and houses to accommodate station buildings and construction depots will generate concrete rubble, plastics, metal, glass, and asphalt from surfaces, wood and refuse.
- Waste from excavation would comprise soil, rubble, sand, rock, brick etc.

Chemical waste

Chemical waste is likely to be generated by construction activities. For those processes, which generate chemical waste, it may be possible to find alternatives, which generate reduced quantities or even no chemical waste, or less dangerous types of chemical waste.

Containers used for the storage of chemical waste shall be

- Suitable for the substances they are holding, resistant to corrosion, maintained in good condition, and securely closed.
- Be of adequate capacity and Display a label in local language and English as to the contents, quantity and safe method of disposal in accordance with instructions contained in Material Supply Data Sheet (MSDS).
- The storage area for chemical waste shall
- Be clearly labelled and used solely for the storage of chemical waste;
- Be enclosed on at least three sides;
- Have an impermeable floor and bunding, of capacity to accommodate 110% of the volume of the largest container or 20% by volume of the chemical waste stored in that area, whichever is the greatest;

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- Have adequate ventilation;
- Be covered to prevent rainfall entering and
- Be arranged so that incompatible materials are adequately separated.

Disposal of chemical waste shall be via a licensed waste collector; duly authorized by MoEF&CC or State Pollution Control Board as the case may be.

Client shall maintain an inventory of chemicals, solvents and adhesives. Minimise disposal of excess material, reuse when applicable and dispose of chemical waste properly shall be maintained at site.

Hazardous Waste

- Any waste which by reason of characteristics such as physical, chemical, biological, reactive, toxic, flammable, explosive or corrosive, causes danger or is likely to cause danger to health or environment, whether alone or in contact with other wastes or substances e.g. oil, grease, Paints etc.
- Classification of waste as Hazardous shall be in accordance with Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016.
- Hazardous waste would mainly arise from the maintenance of equipment. These may include, but not be limited to, the following:
 - Used engine oils, hydraulic fluids and waste fuel;
 - Spent mineral oils/cleaning fluids from mechanical machinery;
 - Scrap batteries or spent acid/alkali; and
 - Spent solvents/solutions, some of which may be derived, from equipment.
- Client shall be responsible to ensure that hazardous wastes are labelled, recorded, stored in impermeable containment for periods not exceeding mandated periods in a manner suitable for handling storage and transport.
- Client shall maintain a record of sale, transfer, storage of such waste and make these records available for inspection and shall approach only Authorized Recyclers for treatment and disposal of Hazardous Waste under intimation to the Project Authority
- The environmentally hazardous waste shall be stored on an impermeable surface with containment bunding to retain leaks, spills and ruptures.
- Waste oil and chemical containers shall be delivered to the Storage yard. Client is responsible for the correct storage and handling of waste oil/waste chemical containers until such a time that they are transported to the chosen disposal area or waste oil containers.
- All waste collection containers shall be of appropriate size with a closed lid.
- Each container will be clearly labelled both with a colour code system and labelled in local language and English.
- Original labels of empty containers should be completely covered over and the contents of the type of waste stored in the used containers clearly indicated.
- Client shall engage an authorized agency for transportation, and disposal/treatment of the hazardous waste which shall be approved by state pollution control board. A record shall be maintained and also submit to PCB.

Biomedical Waste Management:

- Classification of biomedical wastes shall be in accordance with Bio-Medical Waste Management (Amendment) Rules, 2018.
- Client take all necessary steps to ensure that bio-medical waste is handled without any adverse effect to human health and the environment and in accordance with these rules.
- Client shall make a provision within the premises for a safe, ventilated and secured location for storage of segregated biomedical waste in coloured bags or containers to ensure that there shall be no secondary handling, pilferage of recyclables or inadvertent scattering or spillage by animals

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and the bio-medical waste from such place or premises shall be directly transported to the common bio-medical waste treatment facility or for the appropriate treatment and disposal.

- Client shall engage an authorized and approved agency who shall ensure that the bio-medical waste collected is transported, handled, stored, treated and disposed of, without any adverse effect to the human health and the environment, in accordance with the rule and guidelines issued.

Storage and Segregation of Waste

- Disposal and collection points should be established around all construction work sites.
- The burning of refuse at construction sites is not permitted.
- Client shall enter into a contract with licensed Agencies to collect waste from construction sites etc.
- Client is responsible for the separation of construction and demolition material into re-usable and non-reusable materials, and transfer of these materials to low laying areas or landfills, depending on the type of material and the percentage of inert material.
- Segregation of waste should be done on site. All construction waste including debris should be sorted on site into inert and non-inert components. Different areas of the worksites should be designated for such segregation and storage wherever site conditions permit.

Table 8-3: Storage of Waste

Sr. No	Waste Container	Colour Code	Sign
1.	Landfill/Biodegradable	Green	Waste
2.	Recyclable	Blue	Paper and Plastic
3.	Burning/Combustible	Red	Burning
4.	Scrap Metal	Brown	Metal

- On-site measures promoting proper segregation and disposal of construction waste should be implemented e.g. provide separate containers for inert (rubber, sand, stone etc.) and non-inert (wood, organics etc.) wastes. The inert waste should be used on site before disposed of at filling area and the non-inert waste should be sorted for re-use or recycling before being transported to landfills.
- Non-inert materials such as wood, glass and plastic are acceptable for disposal to a landfill as a last resort if these can no longer be reused or recycled.
- Inert materials such as excavated materials comprising soil, rubble, sand, rock, brick and concrete shall be separated and broken down to size suitable for subsequent filling in low lying areas, if it is determined that such material can no longer be reused at the site itself.

Reuse and Recycle

- If some good quality reusable topsoil is found from site clearance, it can also be stockpiled and used later in final landscaping works, thus saving on costs for such works and transportation and environmental impacts of disposal.
- The design of formwork should maximize use of wooden panels so that high reuse levels can be achieved. Alternatives such as steel formwork should be considered to increase the potential for reuse.
- The Contractor should recycle as much of the construction waste as possible on-site. Proper segregation of waste types on site will increase the feasibility of certain components of the waste stream by recycling Contractors.
- Excavated materials are usually inert such as soil and rock, and shall normally be reused on site or in public filling areas.

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- Steel and other metals shall be recovered from the construction waste and recycled as far as practical.

Transportation of Waste

- The transportation of construction spoil shall be allowed only to officially designated dumpsites after obtaining necessary permission from KMRL.
- A procedure to facilitate tracking of loads shall be developed to prevent illegal disposal of waste. This procedure shall include, inter alia, the name of driver, vehicle registration number, type and quantity of waste, place and time of origin, place of disposal and route of haulage.
- In order to avoid dust or odour impacts, vehicles leaving a site carrying excavate shall have their load covered. Vehicles should be routed as far as possible to avoid sensitive receivers in the area.

Training

- The Contractor's Environmental Department is responsible for training of workers and personnel involved in generation of waste.
- The Contractor shall provide training for workers about the concepts of site cleanliness and appropriate waste management procedure, including waste separation, reduction, and reuse and recycling. Failure to do so would result in poorly separated waste, resulting in difficulties in treating the waste correctly and/or a bad market for reuse /recycling.
- The awareness will be created through briefings, toolbox talks, videos, posters, street plays, celebration of internationally recognized days. The personnel/workers should be trained in waste classification and separation. The training should include:
 - Organic waste
 - Combustible waste
 - Hazardous waste
 - Minimization of waste
- Separation awareness training shall be given to employees responsible for the separation of the waste and information regarding waste separation shall be posted at appropriate locations around the site.

Collection & Disposal Method of Different Category of Waste Generated at Site

Table 8-4: Collection & Disposal Method

<i>Sl. No.</i>	<i>Location</i>	<i>Type of Waste generated</i>	<i>Collection Method</i>	<i>Disposal Method</i>	<i>Frequency of Disposal</i>	<i>Remarks</i>
1	Office	Paper	Blue bins	Shall be collected by approved agency	Daily	
2	Store	<ul style="list-style-type: none"> • Oily rags • Empty paint drums, cement bags etc. 	Red Bins Cement bag storage area	Collected by agency As and when generated.	Whenever required	
4	P&M Workshop	<ul style="list-style-type: none"> • Waste oil • Spent oil • Grease • Paints / Thinner • Lubricant 	Red bins	Collected by agency if not reusable.	As and when generated.	

Sl. No.	Location	Type of Waste generated	Collection Method	Disposal Method	Frequency of Disposal	Remarks
5	Worker Rest Room	• Food waste, • Paper	Green bins Blue bins	Shall be collected by approved agency	Once in a day Thrice in a week	Bio-degradable / Recyclable
6	First Aid Room	Different category of biomedical waste	Through Colour coded biodegradable bags	Shall be collected by approved agency	Every alternate day	Infectious waste
7	Canteen	Food waste	Green bins -	Shall be collected by approved agency	Daily	Bio-degradable
8	Diesel & Lubricant Storage area	Spill contained material	Collection Pit & container with leads.	Hazardous waste Agency	As and when generated	Hazardous
9	E- Waste Storage Area	E- waste	Designated storage area	Shall be collected by PCB approved agency	As and when generated	E- waste

8.7.3 Storm Water Management Plan

The purpose of Storm Water Management Plan (SWMP) is to ensure prevention and control of any adverse impact caused by un-regulated storm water runoff from the main plant to the nearby natural drainage channels, surface water bodies, public and private properties.

Following measures will be taken as part of the Storm Water Management Plan:

- All the drains in the project area should be mapped.
- Before initiating any work in surface water drains, necessary permissions should be obtained from concerned regulatory authorities
- Avoidance of disturbance of flows into natural watercourses i.e. provision should be made for temporary or permanent measures that allow for attenuation, control of velocities and capturing of sediment upstream of natural watercourses.
- Do not divert flows out of their natural flow pathways, thus depriving downstream watercourses of water.
- Ensure that all the waste generated due to project is collected and disposed immediately as per waste management plan.
- In no case, waste should be disposed in storm water course / rivers.
- Workers should be trained not to use water from storm water / rivers for any domestic or construction usage, unless permission from concerned regulatory authorities is obtained for the same.
- No labour camp will be setup in 500m from any water body.
- The peripheral drains should be provided along the project alignment during construction phase, which will prevent the silt contaminated surface run-off from site to enter into the adjoining lands or any water body.
- For any diversion (temporary or permanent), permission from concerned regulatory authorities is obtained for the same.
- Any oil / chemical to be used for construction near surface water bodies, should be stored on impervious surface with secondary containment and spill control kit.

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- No spillage of oil or chemical should be discharged on surface water body.
- All effluent and sewage generated due to project activities should be treated / discharged in such a way that it does not cause pollution or contaminate surface water bodies.
- No surface run-off from within the project site or associated facilities will be directly discharged into any nallah/water body.
- Rainwater, if collected from the project site, will be used to recharge the ground water through onsite rainwater harvesting tank/pits.
- Any construction near / in water bodies, information should be provided to relevant stakeholders through appropriate medium, well in advance.

8.7.4 Occupational Health and Safety Management Plan

Occupational Health and Safety Management Plan (OHSP) provides a guidance document for identifying the potential risks involved in a project operation. An Occupational Health and Safety Management Plan needs to be prepared by KMRL to lay down the occupational health and safety measures to be adopted at the corporate level as well as at the site level to minimize the health and safety hazards. This section provides the OHSP applicable to the proposed project. This section also covers the training requirements and safe work practices to be followed onsite to manage various risks involved during the operation phase of the project.

The occupational health and safety plan (OHSP) should address the following:

- Evaluation and Identification of hazards;
- Defining responsibilities to prevent risks;
- Elimination and removal of hazards;
- Control of Hazards which cannot be eliminated; and
- Recovery from accidents.

8.7.4.1 Risk Assessment

Risk assessment is an important step in protecting workers. KMRL / O&M Contractor shall ensure a risk assessment to be performed by a competent person before commencement of operations on site. Such an assessment shall as a minimum:

- Identify the risks and hazards to which persons may be exposed to;
- Analyze and evaluate the identified risks and hazards;
- Document a plan of safe work procedures, including the use of any personal protective equipment or clothing and the undertaking of periodic “toolbox talks” or inductions before undertaking hazardous work, to mitigate, reduce or control the risks and hazards that have been identified;
- provide a monitoring plan; and
- provide a review plan.

Risk assessment includes:

- Identification of hazards, discuss with workers and employees actually working at site, check manufacturer's instructions or data sheets for chemicals and equipment, review accident and ill-health records, long-term hazards to health (e.g. high levels of noise or exposure to harmful substances) as well as safety hazards etc.;
- Identify who may be harmed and what type of injury or ill health might occur;
- Evaluate the risks and decide on precautions to protect people from harm. Consider if the hazard can be eliminated and controlled so that harm is unlikely.

8.7.4.2 Control Measures

Proposed project involves many on job hazards which need to be identified and eliminated or minimized to an expectable level in order to achieve a safe and healthy work environment. Following control measures can be implemented to prevent risks identified on project site:

- Organize work to reduce exposure to the hazard;
- Identification of unsafe working conditions, e.g., falls, electrical hazards, heat/cold stress.
- Provide personal protective equipment (e.g. clothing, footwear, goggles etc.);
- Provide welfare facilities (e.g. First aid and washing facilities for removal of contamination);
- Implementation of LOTO; and
- Record the findings by writing down the findings of the risk assessment.
- The contractors shall comply with Safety, Health and Environment (SHE) Manual along with contract conditions of client related to safety, health and environment.
- Contractor shall prepare a contract specific SHE plans and submit the same to client. These plans should be based on applicable safety, health and environment regulations e.g. Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996, State Building and Other Construction Workers' Rules, Building and Other Construction Workers' Welfare Cess Act, 1996 and Central Rules, 1998, The Factories Act 1948, etc.
- Client shall prepare a plan that identifies proper ventilation, protected clothing and personal protective equipment.
- Safety signage / display boards should be provided wherever required to provide awareness about safety, health and environment aspects.
- The sides of excavations/foundations can be supported by sheet piling or bracing to guard against the danger to workers from fall or dislodgement of earth, rock or other materials.
- Training should be provided to workers about hazards related to the job, usage of equipment and machinery, toolbox talk, health and safety, etc.
- As project site is located adjacent to operational railway line, precautions should be taken while planning work activities considering existing train frequencies, power lines and associated facilities.
- Workers should be provided with adequate personal protective equipment's as per the nature of job/work being carried out.
- Workers shall be given job rotation to minimize the impact of higher noise levels and repeated mechanical shocks and/or vibration.
- Preventive maintenance and servicing of equipment and machinery should be done to avoid any incident and breakdown.
- Each machine and tools should be inspected by the operator and supervisor before start of work.
- Regular inspection and maintenance of the rail lines and facilities shall be carried out to ensure track stability and integrity in accordance with national and international track-safety standards.
- Implementation of an overall safety management program equivalent to internationally recognized railway safety programs is prescribed. Work area should be barricaded and provided with measures to prevent trespassing. To further ensure public safety, the right-of-way close to habitation shall be fenced.
- Pre employment and on job medical check-ups should be carried out for all workers along with health fitness certificate.
- All electrical equipment installed shall have appropriate earthing and shock preventive mechanisms.
- Certified machinery and equipment shall be procured, with approved design safety and industrial standards.

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- Pre-checks or inspection, maintenance and servicing of all machinery & equipment should be done as per scheduled.
- Contractor / client should ensure that a readily available first-aid kit, access to the ambulatory services, tie-up or details of nearby hospitals are continuously available.
- The management of solid waste, effluents, drains at site and labor camp should be done in such a way that there is no nuisance of odor, breeding habitats for mosquito/other vectors of disease, etc.
- Fumigation / anti-mosquito breeding disinfectant should be carried out to control the vectors at site and labour camps.
- The use of corrugated roofing sheets containing asbestos fibres shall be avoided to the maximum extent possible.
- Contractor should provide adequate and safe water supply of drinking water and mobile toilets with septic tank should be provided at project site and labour camp.
- The building and other construction workers' (regulation of employment and conditions of service) act, 1996 requires that
 - No child labour should be involved in any of the activities
 - Only competent person should allow on heavy work.
 - All equipment and machinery shall be inspected before starting the work and all are certified by the competent person.
 - Every worker should be provided training related to job safety and other hazards related to job.
 - Periodical medical check-ups shall be organized for workers.
 - Each worker shall be given personal protective equipment (PPE) which is mandatory to use while working.
 - Each incident should be reported so that preventive measure can be taken to avoid reoccurrence of such incident.
- All machinery and equipment should be covered with acoustic materials. All exhaust should be provided stacks to release of gaseous emission at safe height.
- Efforts shall be made to avoid the storage of hazardous chemicals near any residential area. Hazardous chemicals shall be labelled and stored in locked facility under authorized person. Contractors shall be required to adopt and maintain safe working practices. Usage of appropriate signage in local language at the construction sites should be displayed generously and visibly to make the travellers aware of the ongoing work. Adequate lighting and fluorescent signage shall be provided at the construction sites.
- The camps should be at sufficient distance from such area and labours should be instructed about not using such areas for trespassing and for other activities.
- Regular SHE audits shall be conducted by the contractor with support of expert technical team on regular basis. The frequency of the audit shall be as per the SHE manual. The audit report shall be submitted to KMRL on timely basis. Based on the suggestions given in the audit report; improvement measures shall be taken by the contractor.
- All accidents and dangerous occurrences shall immediately be informed verbally to the KMRL, followed by a written communication giving brief about incident of accident, date/ time of occurrence. This will enable the KMRL to reach to the scene of accident dangerous occurrences to monitor/ assist any rescue work and/ or start conducting the investigation process so that the evidences are not lost.
- The Contractor shall prepare as required under the relevant rules of State Building and Other Construction Workers' Rules, an Emergency Response Plan for all work sites as part of the Contractor SHE Plan.

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- The Contractor shall develop a Work Permit system, which is a formal written system used to control certain types of work that are potentially hazardous. A work permit is a document, which specifies the work to be done, and the precautions to be taken. Work Permits form is an essential part of safe systems of work for many construction activities.
- The contractor should comply with the World Bank accepted guidelines on "Workers' accommodation: processes and standards- a guidance notes by IFC and the EBRD". The contractor shall also comply with standards of International Labour Organization (ILO) and all the other relevant national acts/rules applicable as per the Ministry of Labour and Employment, Government of India.

8.7.4.3 Contract Worker Accommodation Plan

As indicated earlier, approximately 500 workers will be engaged during the peak construction phase of the project estimated to span for a period of 3 years. Out of the total workers engaged during the construction phase, approximately 70 % will be migrant workers from neighbouring states. The migrant workers will be hired specifically for skilled and highly skilled activities for which availability of local labour is limited. Discussions with the project team of KMRL indicate that the migrant workers have been provided with accommodation in a Labour camp. The basic amenities have been provided in the labour camp such as drinking water, toilets, electrical fittings etc. It is to be noted that the Labour camps along with their operation and maintenance will be the responsibility of the EPC Contractor. However, the principal employer i.e. KMRL will be responsible for periodic auditing and review of the labour camp in order to ensure compliance with national laws.

The guidelines/ principles to be followed while undertaking the various key activities during the construction and operations of the labour camp by the EPC Contractor are as follows: -

Designed/ Construction standard

- The height of the rooms should at least be 10 feet;
- The floor should be constructed from PCC Brick work in cement mortar and cement pointing with truss supporting roof or Prefabricated Insulated plastic-coated sheets;
- The minimum area of each room should be 22.5 square metres and the minimum area per person should be 3.5 square metres;
- Maximum 6 numbers of people should be provided accommodation in one room and all of them should belong to the same gender;
- Separate room should be provided to family members;
- There should be separate entry for bachelor's and workers living with their family members in order to ensure privacy of the family members of the workers;
- All rooms should be provided with at least one window for ventilation and adequate illumination;
- External lighting should be provided in the camp area to allow persons to move safely during the night-time;
- Toilets/ drains should be connected to the septic tank and cleaning of the septic tank should be ensured regularly;
- Before construction of the Labour Camp, fire safety assessment should be done of the proposed site by qualified Fire Safety Personnel and all the suggests proposed therein should be incorporated while construction of the Labour Camp;
- Electrical safety norms should be adhered to ensure electrical safety in the Labour Camp e.g. earthing, MCBs, wiring as per electrical load etc.;
- Adequate drinking water should be provided as per generic standards and the same should be monitored on a monthly basis; and
- Sanitation and drainage should be ensured in order to maintain proper hygiene in the Labour Camp.

Drinking water

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- All containers used for distribution of water shall be clearly marked 'Drinking Water Only' or equivalent preferable in local used at site / workers and are not to be used for any other purpose;
- Portable containers used for dispensing of drinking water shall have tight fitting lids and equipped with a tap. These containers should be kept clean and free from contamination;
- Tanker trucks used for transporting portable water shall be clearly identified and shall not be used for any other purpose;
- Outlets dispensing non-drinking water – for washing, bathing and toilets shall be marked 'caution – water unfit for drinking and cooking'; and
- Drinking water should meet national/ local drinking water standards.

Toilet/ Washing/ Showering Facilities

- Adequate toilet/ washing/ showering facilities should be provided in the Labour Camp. The number of toilets and showering facilities will depend on the size of the Labour Camp and the number of workers being accommodated therein;
- Toilet/ Washing facilities should be provided as required to maintain healthy and sanitary conditions in the Labour Camp. Such facilities should be properly maintained and provided with potable water and drainage to prevent pooling of water; and
- The areas shall be checked and cleaned daily by a crew comprising of Sanitation workers. Disinfection of floors, sinks and toilet bowls should be carried out by the EPC Contractor.

Hygiene and housekeeping

- High standard of hygiene and housekeeping shall always be maintained in the Labour Camp;
- The disposal of waste shall be done regularly as required and disposed of in accordance with the applicable local and national regulations;
- Containers for waste materials shall be placed in all areas and cleaned on a regular basis;
- Rubbish should not be dumped or disposed of indiscriminately but shall be stored in sealed rubbish bags at designated collection points for removal by the sanitary crew for disposal;
- No open fires shall be allowed within the Labour Camp; and
- Pest control measures should be in place to control insects and this should include flogging and spraying during the mosquito breeding season.

First aid/ Medical facilities

Access to adequate medical facilities is important to maintain workers' health and to provide adequate responses in case of health emergency situations. The availability or level of medical facilities provided in the Labour Camp/ Worker's accommodation is likely to depend on the number of workers living on site, the medical facilities already existing in the neighbouring communities and the availability of transport. However, first aid must always be available in the Labour Camp.

8.7.4.4 Audit and Inspection

- EPC Contractor and the caretaker of the Labour Camp shall make a weekly inspection and record the observations along with any required corrective actions.
- The EPC Contractor Site-in-Charge will inspect the Camp on a monthly basis along with the Site representative and the Project HR representative of PICMPL. The proposed inspection should use the points illustrated in this document as a guiding tool.
- Non-conformances identified must be corrected within the agreed timeline.
- Non compliances observed during the audit will attract penalty which will be decided by the Project Manager in line with the terms and conditions of the EPC Contract.

8.7.5 Community Health and Safety Plan

Access control and barricading should be done to prevent the entry of unauthorized persons on construction sites which protect people from exposure to construction site activities and any possible accidents. Following additional mitigation measures should be incorporated to avoid/reduce the potential impacts:

- Comprehensive traffic management plan should be prepared to avoid traffic congestion in the region.
- Efforts should be made to avoid heavy vehicle movement during peak traffic hours.
- Use of open ground, community properties, etc. for project activities or parking should not be done without proper permissions of concern authorities.
- The labour camps should be at sufficient distance from nearby habitations and labours should be instructed about not trespassing any other area.
- Efforts should be made to avoid dismantling / malfunctioning of any community infrastructure like road, gas, telecommunication, etc. without prior permission of concern authorities and due intimation to community which will be affected.
- If there is necessary, then contractor should provide other alternative options for locals.
- All community utilities likely to be impacted, such as sources of water, community centre etc. shall be relocated to nearby suitable places.
- The work scheduled should be arranged to avoid any nuisance to nearby communities.
- Use of agricultural land for storage of construction materials and equipment's should be avoided.
- Work area should be barricaded to ensure public safety and access to such area should be prohibited for locals and passers-by.
- Contractors should display appropriate signage in local language at the construction sites to make the travellers aware of the ongoing work.
- The segregation, storage and disposal of various solid and liquid wastes generated at site should be as per relevant applicable national regulations. Disposal of solid and liquid waste should be done at designated areas with proper permission from concern authorities.
- All construction machinery and equipment's should be operated and maintained regularly in such a way so that air emission, noise or vibration related impacts are minimal on nearby community.

8.7.5.1 Construction Area Management Plan

During the construction period, there is a possibility nearby communities are affected by project work. Maintaining construction area is important. Following measures shall be adopted to reduce the inconvenience to the commuters.

- The signage, barricading and other safety and environmental monitoring requirements shall be as per EMP
- The contractor is required to prepare detailed construction methodology plan covering these areas and get the same approved from KMRL before commencement of construction work.
- The contractor shall implement the approved Traffic Management Plan and Material Movement Plan.
- Rehabilitate temporary access roads prior to the contractor leaving the site
- Clearly identify and notify primary routes to the site and issue to all suppliers and Sub- contractors.

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- The Contractor shall plan routes to the site for construction purposes in conjunction with KMRL and affected stakeholders. If the route is passing through the private property, agreements shall be made before starting the construction work. The Contractor shall clearly mark all access roads.
- Where new access roads are constructed, this must be done according to design and specifications agreed by KMRL. KMRL shall ensure the aspect related to natural drainage and erosion while finalizing the access roads.
- All damaged roads shall be rehabilitated using suitable measures. In the event of rehabilitation work being required on private roads, such work shall be done as per the agreed condition with the private landowner.
- Access roads should be maintained in good condition by attending to potholes, and storm water damage as soon as these develop due to construction activities
- At no given time, access of any area should be closed
- All the hazardous material shall be stored properly on the construction site.

8.7.6 Traffic Management Plan

The Contractor shall develop, assess, and implement appropriate management measures for traffic management wherever the construction activity will affect or likely impact the efficiency and safety of road and related transport networks (including traffic flow, access, parking and user safety). Traffic management plan shall be prepared in consultation with the relevant road authority, transport operator, and emergency services, as relevant. This will be required for movement of man, material and machinery to the construction site nearest to the railway premises. A detailed traffic management plan shall be prepared by the contractor for Panvel-Virar and submitted to client for approval. Based on these guidelines Contractor shall prepare detailed traffic management plan and material movement plan and get the same approved by client. The broad guideline for preparation of Traffic Management Plan is as follows:

Construction Phase:

- The basic requirements of Road Traffic Management to be followed during construction activity to ensure that:
 - Road capacity is sufficient to accommodate construction vehicle traffic volumes and that disruptions are minimized
 - Appropriate warning and information signs are installed to provide advance warning of changed traffic conditions
 - Information and guidance are provided on how to make the construction site safe from construction vehicles
 - Understand the requirements of barricades for pedestrians, public transport passengers, motorists, cyclists etc.
 - Work activities are planned and undertaken to minimize any adverse impacts and to ensure that the traffic normalcy is resumed in shortest possible time
 - Suitably trained staff perform daily inspections on implemented Traffic Management Plans
 - Measures for managing parking impacts, including any proposed alternative parking arrangements are developed
 - Pedestrian impacts are identified and managed
- Necessary permissions shall be obtained from traffic department of urban/rural local bodies and Road Authorities such as Commissioner of traffic. Details of the barricade construction, area of enclosure and period of work are required to be submitted to the satisfaction of the authority.
- All vehicles involved in the excavation and/or demolition process and departing the property with demolition materials, spoil or loose matter must have their loads fully covered before entering the public roadway. Prior to the commencement of work, suitable measures are to be implemented to

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ensure that sediment and other materials are not tracked onto the roadway by vehicles leaving the site. It is an offence to allow, permit or cause materials to pollute or be placed in a position from which they may pollute water.

- Loading and Unloading During Construction shall have following requirements:
 - All loading and unloading associated with construction must be accommodated on site.
 - If, during excavation, it is not feasible for loading and unloading to take place onsite, a Works Zone on the street may be considered. Prior approval is required from authorities.
- Any materials, vehicles, refuse, skips or the like, under any circumstances, must not obstruct the public way.
- For special operations including the delivery of materials, and erection and dismantling of on-site tower cranes which warrant the on-street use of mobile cranes, permits must be obtained from authorities for the use.
- In the case of full road closures and partial road closures, which can create significant traffic disruptions, the authorities shall be informed well in advance and necessary permissions to be obtained.
- Mobile cranes operating from the road must not be used as a method of demolishing or constructing a building.
- Special operations and the use of mobile cranes must comply with the approved hours of construction.
- Contractor shall ensure that demolition and construction related impacts (including construction noise and vibration, loading, issues associated with construction workers and vehicles, traffic issues, management of the construction site) from the site can be dealt with expeditiously and cooperatively.
- Traffic Management Plan shall address following sections:
 - Site location and road network
 - Approved development
 - Overall principles for traffic management
 - Hours of work
 - Truck routes
 - Traffic and parking effects
 - Pedestrians
 - Consultation
 - Pedestrian and traffic management plan
 - Construction site access, including the efficient and safe egress and ingress of vehicles
 - The movement of trucks on and off the site to be managed and controlled by appropriately qualified site personnel in accordance with a Safe Work Method Statement and Traffic Control Plans
 - Truck movements to and from the site to be restricted. Contractor shall provide a diagram showing designated truck routes
 - Parking management, including on and off street and remote parking and access haulage management, including works to facilitate haulage vehicles, the restriction of haulage vehicles in peak traffic periods
 - Pedestrian activity across the site access driveways will be managed and controlled by appropriately qualified site personnel

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- Appropriately qualified traffic controller's pedestrian warning signs to be displayed at appropriate locations will supervise reversing movements to and from
 - Pedestrian arrangements, construction activity and erection of safety fencing will be provided
 - Mass movement of vehicles in and out of construction site such as RMC delivery Trucks
 - Debris removal from site etc. – Preferred time non-peak hours
 - Restriction on movement of vehicles through congested roads, narrow lanes having sharp turning radius
 - Safety in transporting heavy machinery at site such as use of slings, hoists or jacks for blocking or preventing falling or shifting of machinery
 - Neutral position of motors / Engines and parking brakes set during parking and stoppage to be ensured
 - Speed and overload restrictions
 - Compliance under Central Motor Vehicles Rules, 1989 and latest amendments
- Material Movement Plan also shall be prepared by the contractor and submitted for approval. The contractor shall ensure the regular movements of the existing trains and safety of the workers while material movement from East to West or West to East.

Operation Phase:

- After construction, the metro operations will be handed over to concerned department. The concerned department will ensure traffic dispersal on proposed routes as per their operational guidelines.
- The relevant management plan mentioned above should be followed.

8.7.7 Environment and Social Monitoring Plan

8.7.7.1 Environmental Monitoring Plan

The objective of environmental monitoring plan is to:

- Evaluate the performance of mitigation measures proposed in the EMP
- Suggest improvements in management plan, if required.
- Enhance environmental quality
- Comply with the Statutory and community obligations
- Warn significant deteriorations in environmental quality for further preventive action

This exercise will aid implementation of mitigation measures by way of generating a continuous feedback system in structured format. At the same time, this could be used for conducting corrective action in respect of pitfalls as noticed during inspections. Effectiveness of the proposed mitigation measures during the construction period will be monitored using key environmental performance indicators, which are described below. The key Environmental Performance Indicators that will be used to evaluate the effectiveness of the proposed environmental safeguards in relation to community health and safety in the project area are:

Noise and Vibration Level Monitoring -

- Air Quality
- Water Quality
- Noise & Vibration Level

Air Quality Monitoring

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The air quality monitoring is recommended through NABL accredited / MoEF&CC approved laboratory during the construction phase of the project. The monitoring of air shall be mainly conducted at the proposed stations, casting yard and stock yard. Air quality shall be analysed as per the National Ambient Air Quality Standards (2009), CPCB. Parameters: Suspended Particulate Matter (SPM), Particulate Matter (PM_{2.5} and PM₁₀), Sulphur dioxide (SO₂), Nitrogen oxides (NO_x), Carbon Monoxide (CO), Hydrocarbons (HC).

The monitoring should be carried out at least once for continuous 24 hr, once every month during construction phase and 3 times in a year (3 seasons) in a year during operation phase and compared with the AAQ monitoring results obtained during the baseline monitoring to record changes in the AAQ and undertake suggested measures to mitigate the adverse impacts. The detailed Ambient Air Quality Monitoring Plan is presented in table below. The additional locations if required; shall be identified by the Contractor with help of Environment Cell of client.

Water Quality Monitoring

Water quality shall be monitored for surface water and groundwater having frequency of once in 3 months (4 times a year) throughout the project construction duration . Surface water should be monitored for parameters as per CPCB Designated Best Use classification and groundwater should be monitored for the parameters of IS:10500. The detailed Water Quality Monitoring Plan is presented in table below. The additional locations if required; shall be identified by the Contractor with help of Environment Cell of MRVC.

Noise and Vibration Level Monitoring

Noise and vibrations are to be monitored for 24 hours once every month during construction phase at proposed stations and casting yard and stock yard and once every month at stations during operation phase. Ambient Air Quality Standards in respect of Noise prescribed in Noise Pollution (Regulation and Control) Rules, 2000 (see rule 3(1) and 4(1)) shall be adopted for noise monitoring. Permissible limits of ground vibration specified by Director General of Mines Safety (DGMS) through its Circular No. 7 of 1997 or German standard guideline 'DIN 4150-3: 1999-02 - Vibration in buildings - Part 3: Effects on structures' can be used for assessing vibration.

The detailed Noise and Vibration Level Monitoring Plan is presented in Table 8-5. The additional locations if required; shall be identified by the Contractor with help of Environment Cell of client.

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Table 8-5. Environment Monitoring Plan

Sr. No	Environmental Attribute	Sampling location	Criteria for Selection	Monitoring Frequency	Construction Phase	Operation Phase
Construction Phase						
1.	Ambient Air Quality	Eloor Casting Yard	Construction and management	Once in a month (12 times a year)	Client through Contractors	Client
2.	Ambient Air Quality	Stock Yard - Irumpanam	Construction and management	Once in a month (12 times a year)	Client through Contractors	Client
3.	Ambient Air Quality	Vadakkekkotta Station	Proximity to construction work & increased rail traffic	Once in a month (12 times a year)	Client through Contractors	Client
4.	Ambient Air Quality	S N Junction	Proximity to construction work & increased rail traffic	Once in a month (12 times a year)	Client through Contractors	Client
5.	Ambient Air Quality	Tripunithura Station	Proximity to construction work & increased rail traffic	Once in a month (12 times a year)	Client through Contractors	Client
6.	Noise Monitoring	Eloor Casting Yard	Construction and management	Once in a month (12 times a year)	Client through Contractors	Client
7.	Noise Monitoring	Stock Yard - Irumpanam	Construction and management	Once in a month (12 times a year)	Client through Contractors	Client
8.	Noise and Vibration Level Monitoring	Vadakkekkotta Station	Proximity to construction work & increased rail traffic	Once in a month (12 times a year)	Client through Contractors	Client
9.	Noise and Vibration Level Monitoring	S N Junction	Proximity to construction work & increased rail traffic	Once in a month (12 times a year)	Client through Contractors	Client
10.	Noise and Vibration Level Monitoring	Tripunithura Station	Proximity to construction work & increased rail traffic	Once in a month (12 times a year)	Client through Contractors	Client
11.	Water Resources – Surface Water	North of Champakara	Project water demand	Once in 3 months (4 times a year)	Client through Contractors	Client
12.	Water Resources – Surface Water	South of Champakara	Project water demand	Once in 3 months (4 times a year)	Client through Contractors	Client
13.	Drinking Water	Eloor- Labour camp	Construction and management	Once in a month (12 times a year)	Client through Contractors	Client
14.	Drinking Water	Labour camp - Irumpanam	Construction and management	Once in a month (12 times a year)	Client through Contractors	Client
15.	Ground Water	Mutton Depot	Construction and management	Once in a month (12 times a year)	KMRL	Client
Operation Phase						
16.	Ambient Air Quality	S N Junction	Proximity to construction work & increased rail traffic	Once in a month (12 times a year)	Client through Contractors	Client

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Sr. No	Environmental Attribute	Sampling location	Criteria for Selection	Monitoring Frequency	Construction Phase	Operation Phase
17.	Ambient Air Quality	Tripunithura Station	Proximity to construction work & increased rail traffic	Once in a month (12 times a year)	Client through Contractors	Client
18.	Ambient Air Quality	Vadakkekkotta Station	Proximity to construction work & increased rail traffic	Once in a month (12 times a year) <i>Once in a month (12 times a year) during first year of operation</i> Once in 3 months (4 times a year) <i>Once in a month (12 times a year) after first year of operation</i>	Client through Contractors	Client
19.	Water Resources – Drinking Water	S N Junction	Project water demand	Once in a month (12 times a year) <i>Once in a month (12 times a year) during first year of operation</i> Once in 3 months (4 times a year) <i>Once in a month (12 times a year) after first year of operation</i>	Client through Contractors	Client
20.	Water Resources – Drinking Water	Tripunithura Station	Project water demand	Once in a month (12 times a year) <i>Once in a month (12 times a year) during first year of operation</i> Once in 3 months (4 times a year) <i>Once in a month (12 times a year) after first year of operation</i>	Client through Contractors	Client
21.	Water Resources – Drinking Water	Vadakkekkotta Station	Project water demand	Once in a month (12 times a year) <i>Once in a month (12 times a year) during first year of operation</i> Once in 3 months (4 times a year) <i>Once in a month (12 times a year) after first year of operation</i>	Client through Contractors	Client
22.	Ground Water	Mutton Depot	Construction and management	Once in a month (12 times a year) <i>Once in a month (12 times a year) during first year of operation</i> Once in 3 months (4 times a year) <i>Once in a month (12 times a year) after first year of operation</i>	KMRL	Client
23.	Noise and Vibration Level Monitoring	S N Junction	Proximity to construction work & increased rail traffic	Once in a month (12 times a year) <i>Once in a month (12 times a year) during first year of operation</i> Once in 3 months (4 times a year) <i>Once in a month (12 times a year) after first year of operation</i>	Client through Contractors	Client
24.	Noise and Vibration Level Monitoring	Tripunithura Station	Proximity to construction work & increased rail traffic	Once in a month (12 times a year) <i>Once in a month (12 times a year) during first year of operation</i> Once in 3 months (4 times a year) <i>Once in a month (12 times a year) after first year of operation</i>	Client through Contractors	Client
25.	Noise and Vibration Level Monitoring	Vadakkekkotta Station	Proximity to construction work & increased rail traffic	Once in a month (12 times a year) <i>Once in a month (12 times a year) during first year of operation</i> Once in 3 months (4 times a year) <i>Once in a month (12 times a year) after first year of operation</i>	Client through Contractors	Client

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8.7.7.2 Social and Health and Safety Monitoring Plan

Working conditions on site with respect to health and safety of the workers and concerns from the communities are required to be monitored regularly to ensure the positive impacts of the mitigation and management measures taken for the anticipated impacts.

Table 8-6 Health and Safety Monitoring Plan

S. No.	Attribute	Monitoring Parameter	Monitoring Frequency	Responsibility
1	Health and Safety Risks	Sanitation status of onsite office building	Monthly	Site Manager
		Potable nature of drinking water with respect to BIS drinking water standards 10500:2012;	Monthly	Site Manager
		Usage of adequate PPEs;	Monthly	Site Manager
		Electromagnetic field	Monthly	Site Manager
		Adequate Health and Safety Training to workers	Monthly	Site Manager
		Fire Safety measures on site	Monthly	Site Manager
		Incident/ Accident Records	Monthly	Site Manager
		Permit to Work Records	Monthly	Site Manager
		LOTO records	Monthly	Site Manager
		OHSMP of the project	Monthly	Site Manager

The Social Monitoring Plan is given in the table below.

Table 8-7 Social Monitoring Plan

S. No.	Attribute	Monitoring Parameter	Monitoring Frequency	Responsibility
1.	Land acquisition; Loss of livelihood; Vulnerable groups affected by project	Review of the SIA report by KMRL	One-time at the stage of completion of SIA study	KMRL Project Management
		Revisions in (a) the number of projects affected persons, (b) Compensation disbursement status and (c) R&R beneficiaries	One-time at the stage of completion of SIA study	KMRL Project Management
		Annual Impact Evaluation exercise to assess outcomes of compensation and R&R on all project affected people	Annual until completion of all land acquisition, disbursement of compensation and R&R provisions for the entire IA and IB.	KMRL Project Management to hire an external agency with expertise in monitoring and evaluation
2.	Local employment creation – construction phase	Any new contractors engaged should be instructed to give preference to locals for employment and the contract agreements should mention a clause on local employment creation.	Quarterly verification by HR Department;	KMRL and its contractors
		Human Resources Department to maintain a ratio of migrant vis-à-vis local workers on quarterly basis for all contractors and sub-contractors providing services and human resources for the project.	Changes in Contract Agreements – at the time of hiring new contractor.	
3.	Local employment creation	Internal Audit for Working and Living Conditions of contractual workforce with focus on retrenchment procedures.	Prior to end of construction phase	KMRL Project Management and HR Department
4.	Labour influx	Internal Audit for Working and Living Conditions of contractual workforce; inclusive of: verification of medical records at the time of joining work for the project,	Twice a year.	KMRL HR Department

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S. No.	Attribute	Monitoring Parameter	Monitoring Frequency	Responsibility
		procedure followed in case of a worker shows symptoms of or is tested positive COVID-19.		
5.	Local employment creation during operations phase	Gender-sensitization programs to be arranged for KMRL employees and workers.	Prior to commencement of Operations phase of the project; Refresher as and when required.	KMRL HR Department

8.7.8 Emergency Preparedness and Response Plan

The primary objective of formulating Emergency Preparedness and Response Plan (EPRP) is to undertake immediate rescue and relief operations and stabilize the mitigation process as quickly as possible. The main parameters of a response plan based on such mechanism include:

- Identification and declaration of potential emergencies;
- Signal/warning mechanism;
- Activities and their Levels;
- Command and control structure;
- Individual roles and responsibilities of each specified authority to achieve the activation as per response time;
- Emergency procedures;
- Alternate plans & contingency measures; and
- Co-ordination with external parties

8.7.8.1 Responsibilities

The Site EHS Coordinator will be responsible for implementing this procedure, which includes

- Ensuring that the emergency preparedness measures are in place;
- Providing training to the personnel at site regarding reporting of the emergencies, and to site office personnel regarding response to emergency calls from the site personnel,
- Direct action-and co-ordination at the time of an emergency

8.7.8.2 Identification of Emergencies

All the anticipated hazards and risks associated with each project activity, which may lead to an emergency are identified in the section, along with the required actions to be taken before or after the emergency arises. This section identifies the hazardous areas and activities in the operation phases. Probable emergencies that might arise due to these hazards for the duration of the project have been listed below.

Hazardous Areas

Following potentially hazardous areas and activities have been identified at the construction site:

- Fuel storage areas
- Electrical installations – improper laying of cables
- Transformer Area
- Hazardous waste storage area
- Broken/ defunct panel storage area

Emergency Situations

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The possible emergency situations identified for the operation phases of the Project are as listed below:

Fire and Explosion

- Leakage of fuel from storage areas; and
- Short-circuit at project site.

Mechanical and Electrical Hazards

- Accidentally dropped object;
- Electrocution.

Occupational Hazards

- Handling of chemicals;
- Electrocution;
- Accidents due to vehicle movement; and
- Vandalism.

Trip and Fall/ Crushing Hazard

- Collapse of lifting appliances and transport equipment during construction stage of metro support structures
- Collapse of buildings, sheds or structure

Hazards caused due to Natural Calamities and external factors

- Drowning of workers
- Landslides getting workers buried in floods, earthquakes, storms and other natural calamities
- Bomb Threats (Criminal or terrorist)

8.7.8.3 Declaration of Emergencies

Level 1 (Minor Emergency)

All events with no escalation potential and which can be controlled and contained by the action of Safety Officer at the site will be considered as Level 1. In such cases of local alert, Site EHS Manager will be notified. Some typical incidents are:

- Vehicle collision (involving no loss of life);
- Equipment damage;
- Medical Evacuation (not very serious cases);
- Minor fires.

Level 2 (Serious Emergency)

All events with escalation potential, depending on the effectiveness of the local response will be considered as Level 2. These incidents may impact the entire project operations or have cascading effect. For such type of incidents Site Manager will take the lead. Some typical incidents are:

- Substantial security incident / Vandalism;
- Structural collapse;
- Minor Flooding;
- Serious damage to structures;
- Substantial fire; and

- Cultural conflict.

Level 3 (Major Emergency)

The crisis that requires assistance from external resources in order to save lives, minimize damage and to bring the abnormal situation back under control are Level 3 emergencies. These incidents have the potential to impact beyond the project footprints and affect the community. In such cases appropriate government / regulatory authorities will be informed and involved. Some typical Level 3 incidents are:

- Major fire/explosion;
- Fatality;
- Severe flooding.

Personnel on site will know that a Major Emergency has been declared if the site fire alarm siren and /or the local fire alarm systems are activated. The Emergency Siren Modes will be demonstrated and shared with all workers to identify with them.

Level 2 and level 3 will be declared using emergency siren and evacuation shall be done.

8.7.8.4 Emergency Equipment

The following points should be implemented to tackle emergency situations:

- Onsite emergency equipment such as first aid boxes, firefighting equipment, PPEs etc. shall be maintained at project site;
- The adequacy and availability of emergency equipment shall be assessed at periodic intervals by the EHS Manager;
- Inventory and locations of respective emergency equipment shall be displayed at project office building and other work areas;
- It is to be ensured that the site staff is trained on usage of each type of emergency equipment.

First Aid Boxes

First aid boxes shall be provided at identified locations within the plant premises. A first aid box shall contain, but not limited to the following articles:

- Cotton wool
- Sterile gauze
- Antiseptic lotion
- Box of adhesive dressing (Plasters) for small wounds
- Blunt-ended scissors
- Tweezers for removing splinters
- Triangular bandages (for making a sling or emergency bandage)
- Safety pins
- Sterile eye dressings
- Crepe bandages
- Aspirin/ Paracetamol tablets
- Skin creams for treating burns
- Anti-histamine cream for insect bites and stings

Fire Fighting Equipment

During operation phase, fire extinguishers and sand buckets shall be provided at critical areas such as fuel storage area, waste storage area, areas with electrical installations and project office.

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Other firefighting systems to be installed should include:

- Heavy-duty ABC powder type fire extinguishers kept at important electrical equipment areas;
- Portable CO₂ extinguishers provided throughout the plant

Provision of Personal Protective Equipment (PPE)

Onsite workers and site staff should be provided with adequate number of personal protective equipment (PPEs) to deal with emergency situations. The PPEs shall be stored at the designated Emergency Control Centre (ECC) in the plant premises and will be easily accessible during times of emergency. Training of proper use of PPEs shall be provided to all working personnel on periodic basis.

Assembly Area

Safe assembly area shall be identified and marked and employees to be instructed to gather at the assembly area during emergencies.

Codification of Sirens

The following codes of siren will be following during emergencies:

Table 8-8 Codification of Siren

Sr. No	Siren	Indicate	Authority
1.	120 seconds Continuous Whelming Sound	ON SITE EMERGENCY (ALERT) for evacuation	Plant Head/ EHS Manager
2.	30 + 30 + 30 seconds Sound with an interval of 5 seconds each	EMERGENCY CONTROLLED	Site Manager/ Site EHS Manager

Below points shall be noted during prevalence of emergency situation:

- Emergency siren to be sounded only if required.
- All staff shall be prior informed of use of emergency sirens during mock drills.
- No worker will leave the emergency spot unless 'all clear' siren blown.

8.7.8.5 Coordination with External Agencies

During emergency situations, Site Manager and Site EHS Manager shall form the Emergency Control Centre (ECC). Site EHS Manager shall coordinate with the following departments:

- Fire brigade;
- Police department;
- Hospitals/ Ambulance Services;
- Utility departments (electricity and water);
- Technical departments such as GPCB, Factory Inspectorate etc.
- Local Authorities and District Administration
- District Disaster Control Room.

8.7.8.6 Emergency Response Team

- The Emergency Response Team (ERT) shall be set up immediately for the project;
- Each personnel identified as part of the ERT shall be designated specific roles and responsibilities for handling emergency situations.
- The ERT at the operating site under its control will have following role:
 - Control the emergency and render the facility premises safe by the application of local resources; and

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- Support the local response effort by coordinating additional equipment, personnel, and other external resources for the direct response effort.
- The ERT will comprise of the following personnel:
 - Site Manager;
 - Site EHS Manager;
 - Safety Officer(s);
 - Evacuation Officer;
 - Employee/Workers

8.7.8.7 Emergency Response Procedure

Effective command and control start with a clear definition of the overall command and control structure, and description of the duties of key personnel with specific responsibilities for emergency response. The control of emergencies will consider the minimum number of persons required to provide an adequate response to emergencies.

All emergencies occurring as a result of project activities shall be managed according to the following order of priorities:

- Preservation of Life (self, team, community);
- Protection of the Environment;
- Protection or Property/assets; and,
- Preservation of Evidence.

8.7.8.8 Onsite Emergency Response Plan Road Map

The onsite Emergency Response Plan Road Map has outlined the closest route to Vijaya Kumara Menon (located 1.1 km away -as the nearest hospital). The map outlines different ailments for which the patients can be transported to the hospital. Additionally, the map lists the contact information for the hospital.

8.7.8.9 Monsoon Emergency Plan

Contractor has prepared a site-specific monsoon emergency plan to prevent any fatalities, accidents, injuries or loss of equipment/ materials. Highlights of the plan include the following:

- The plan lists precautions to be taken before the start of monsoon season to prevent creation of hazardous situations capable of causing injuries or fatalities and losses to equipment and materials.
- The plan also outlines activities prohibited during a rain event or storm.
- Plan provides an outline of what activities to carry out post such an event, prior to resuming normal activities.
- Section 6 of the Plan identifies dangerous situations and provides mitigation measures for each event for:
 - Electrical installations
 - Traffic management
 - Waterlogged areas
 - Working at heights
 - Lifting Appliances
 - Storage and stacking
 - Lightning
- The Plan also identifies key emergency response committee members and outlines their roles and responsibilities and their contact numbers
- The Plan depicts the emergency response procedure to ensure ease of implementation.

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8.7.8.10 SOP for Handling Flood in Muttom Depot

- This procedure is applicable to all KMRL O&M staff and other stake holder staff working in the Mainline and Muttom Depot.
- The report provides general guideline on evacuating personnel during floods and how to prevent water from entering areas.
- Document outlines responsibilities of key personnel on dealing with floods.

8.7.8.11 Reporting and Documentation

The following aspects need to be communicated for the emergency reporting:

- While witnessing or receiving notification of an emergency, as much information as possible should be taken and/or conveyed to the relevant emergency activation authority;
- Where possible, all information should be logged in written form with time and date included and provided to EHS Manager;
- Personnel working on the site may, at any time, be exposed to an emergency which could take many forms, for example (but not limited to):
 - Injuries and/or fatalities
 - Fires and/or explosions
 - Extreme weather
- When an emergency occurs, an appropriate and prompt response is required, providing precise action to control, correct and return the site to a safe condition. Timely action will also be required to protect people, the environment and property from damage; and
- All near misses and unsafe acts will be written in logbooks / reported in the 'near miss, unsafe acts, hazards and sub-standard conditions report' and verbally communicated to the concerned Site Supervisor within a reasonable time.

8.7.9 Stakeholder Engagement Plan

8.7.9.1 Purpose

A Stakeholder Engagement Plan (SEP) has been prepared for KMRL in order to ensure that a consistent, comprehensive, coordinated and culturally appropriate approach is taken to stakeholder engagement, information dissemination and grievance redressal through the life of the project.

KMRL is committed to full compliance with all Indian Regulations as well as aligning to the international standards, namely the ADB Safeguard Policy Statement, and any other directly relevant policies of the IFC and World Bank. In line with current international best practice, this SEP aims to ensure engagement that is free of manipulation, interference, coercion and intimidation. It also aims to ensure that stakeholder engagement is conducted based on timely, relevant, understandable and accessible information, in a culturally appropriate format. In this way, the SEP seeks to ensure that stakeholder groups are given enough opportunity to voice their opinions and concerns, and that these concerns influence project decisions.

The SEP is developed to assist the project proponent and the contractors to meet the objectives of identification of various stakeholders and draw means to address the potential concerns that may arise during the project lifecycle. The SEP is based on the socio-economic baseline, identification of stakeholder groups during the ESIA process and applies to all activities that may involve, impact, interest or engage these groups through the pre-construction, construction and operations phase.

8.7.9.2 Scope and Objectives

The SEP applies to Kochi Metro Phase IA and IB constructions and operations phases. Stakeholders are those external to KMRL's operations who are interested in the project and/or have ability to influence project activities. Such as the families and persons affected by project, government authorities of Ernakulam, those who commute along the metro alignment, media etc. Stakeholders such as KMRL employees, contractors, workers, vendors are not addressed in this SEP, as they are part of core business function and subject to national regulations and established company policies and procedures.

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The SEP is a living document that needs to be regularly updated to include and enable documentation of all consultation activities proposed and undertaken (Monitoring); and reviews of appropriateness and effectiveness of methods used in engaging with stakeholders (Evaluation).

The key objectives of the SEP are as follows:

- Maintaining positive legal compliance to applicable stakeholder engagement and disclosure regulations and standards;
- Compliance to the applicable stakeholder engagement commitments in the ESMP and associated framework management plans;
- Providing an engagement mechanism to mitigate any reputational risk arising from site activities and their impacts;
- Identifying engagement methods, in keeping with the profile of the stakeholders and principles of inclusiveness, transparency and cultural appropriateness;
- Allowing for information disclosure and stakeholder grievance resolution in a timely and culturally appropriate manner, to allow for informed and meaningful engagement; and
- Establishing accountability of the project proponents by assigning adequate resources and responsibilities for effective stakeholder engagement.

8.7.9.3 Principles of Stakeholder Engagement

The implementation of the SEP, its review and update will be aligned and guided by the following principles:

- Interests, influence, issues and concerns of the relevant stakeholders will inform KMRL's engagement levels and methods;
- All engagement levels and methods will be developed around the principles of inclusiveness and transparency. Where required, mechanisms on Stakeholder and Community Engagement will be tailored to stakeholder needs and modified for cultural appropriateness;
- KMRL will ensure informed consultation and participation of all stakeholder groups that are impacted and/or interested by the Company's environmental and social impacts, including land procurement, community health & safety, ecosystem services and influx management;
- KMRL commits to promote awareness of this Policy for its employees, partners and contractors through training and communication; and
- KMRL commits to documenting, monitoring and reporting on its stakeholder engagement performance;
- The engagement activities undertaken shall be in cognizance of the cultural norms and practices of the stakeholder groups as well as the differences in social position of the various groups;
- The stakeholder engagement process should demonstrate a commitment and persistence in the efforts to achieve real outcomes on the challenging issues and opportunities;
- As the project/site lifecycle progresses through the various stages, the engagement activities will evolve based on the experiences and learnings from the previous engagement undertaken.

8.7.9.4 Roles and Responsibilities

KMRL needs to assign a dedicated person with responsibilities of implementation of the SEP. This person may function as a Public Relations Officer or equivalent designation. Key responsibilities of the person would include:

- Liaoning with local government authorities,
- Conduct community meetings and consultations with all stakeholders,
- Designing and overseeing studies such as Needs Assessment,
- Co-ordinate with the Grievance Redress Cell (GRC) for resolution of project related grievances,
- Help prepare CSR Plans as per specific needs of the stakeholders,
- Facilitate the impact evaluation of the environmental and social impacts created by the project,
- Identification of the project stakeholders,
- Documentation and maintenance of the database of all engagement activities,
- Update the SEP as required.

8.7.9.5 Engagement Mechanisms

The range of stakeholder groups identified within the ESIA can be grouped into the following:

- Project affected families and persons;
- Project affected Vulnerable Groups;
- Local communities;
- Land Acquisition and Resettlement and Rehabilitation Authorities;
- Other interested entities, including civil society organisations.

The engagement activities undertaken shall be aligned to the business objectives, priorities and the identified issues/impacts/risks associated with the project. This will also result in a variation in the engagement activities undertaken, across the various phases of the project/ business lifecycle, depending upon the impacts and risks associated with each phase. As part of the planning, the engagement activities shall be prioritized based on their material significance to immediate and long-term interests of the Stakeholder Engagement Plan.

Table 8-9: Stakeholder Engagement Mechanisms

Stakeholder Group	Key Issue/ Relevance to the project	Focus Areas for Engagement	Engagement Strategies	Tools, Methods and Frequency of engagement
Project Affected Families	<ul style="list-style-type: none"> The incoming of the project has resulted into expropriation of land, assets, and livelihood opportunities from two villages and two municipalities of Ernakulam district; Several members of the community who did not own land but have been indirectly impacted by the project. Such as the tenants, the workers employed at shops, the users of access roads and likewise; The various entities impacted by the project must be compensated through adequate entitlements. 	<ul style="list-style-type: none"> Livelihood restoration activities; Priority in local employment; Grievance management; Feedback on mitigation measures. 	<ul style="list-style-type: none"> Project representatives could identify training agencies to provide skill training for capacity building of the livelihood losers. This will provide diversified options of employment to the people and minimize any possibility of social discontent towards the project/company corresponding to the loss incurred; The project could offer suitable employment to this stakeholder group within company or refer the unemployed to other suitable employment opportunities in case there is lack of prospects within the project. By doing this the stakeholders will become a part of the project and the company will have strong support from the affected families by having their representation in project operation; The company could conduct a mid-term impact evaluation in order to understand the level of livelihood restoration achieved and needs/priorities for community investment. 	<ul style="list-style-type: none"> Quarterly meetings with the Local Self Governments of Poonithura, Nadama villages and Kochi Corporation, Thripunithura municipality; Annual impact evaluation study for monitoring of outcomes of the compensation and R&R provisions made; Quarterly meetings with the R&R Implementation Authorities (presently the LAO is responsible for the same) to understand and document the progress of grievance handling.
Vulnerable Groups	<ul style="list-style-type: none"> The vulnerable groups as categorised by the SIA studies for the project comprise of women headed households, families with elderly persons, families with widow persons, families with physically and mentally disabled persons, landless families, economically backward families etc; The project compensation and R&R provisions must be gender-inclusive 	<ul style="list-style-type: none"> Capacity building for improved employability; Development interventions specific to their needs; Grievance management; Feedback on mitigation measures. 	<ul style="list-style-type: none"> Primarily, the project could undertake a Needs Assessment Study of the vulnerable groups identified to be impacted by the project; Project representatives could identify training agencies to provide skill training for capacity building of this stakeholder group based on the results of the Needs Assessment Study; 	<ul style="list-style-type: none"> Needs Assessment Study for the vulnerable groups impacted by the project; Annual impact evaluation study for monitoring of outcomes of the compensation and R&R provisions made for this stakeholder group.

Stakeholder Group	Key Issue/ Relevance to the project	Focus Areas for Engagement	Engagement Strategies <i>Tools, Methods and Frequency of engagement</i>
Local Community <ul style="list-style-type: none"> The local community comprises of those living, working, and visiting the 3km stretch of the metro alignment. The people passing by the road alignment include, doctors and patients visiting the hospitals, teachers and students enrolled at the education institutes on the alignment, customers visiting the restaurants and shops, worshippers visiting the religious structures, travellers passing through the road in different vehicles (buses, cars, motorbikes etc.); They are sensitive receptors of the increased traffic congestion, increasing levels of air and noise pollution, who may face delays in commute or temporary restrictions of access, exposed to accidents below the elevated under-construction metro tracks; This stakeholder group also consists of persons interested in employment in the project. 	<ul style="list-style-type: none"> Adherence to the project schedule and timelines; Preference in employment (<i>first preference remains for persons from vulnerable groups</i>); Grievance management. 	<ul style="list-style-type: none"> The project has a Right to Information (RTI) team responsible for answering all project related queries routed through RTI. The same could continue functioning throughout the project lifecycle. This will give assurance to the local community about project's accountability toward the society at large; Project to implement the GRM that is prepared as part of this ESIA for dealing with the concerns and grievances of this stakeholder group. For example, the helpline number displayed on the KMRL website could be used to handle and document suggestions, queries, and feedback from this stakeholder group. Currently its purpose and use are not clearly understood; Project could adhere to the schedule of activities in order to start the metro as per the determined timelines. This allows the metro to start operating soon and ease the traffic congestion and provide faster mode of commute for locals; Project representatives can plan CSR activities for social development as per the needs of the community. 	<ul style="list-style-type: none"> Quarterly meetings with the Local Self Governments of Poonithura, Nadama villages and Kochi Corporation, Thirunithura municipality; Tracking of local community grievances in the Quarterly Reports of the company.

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Stakeholder Group	Key Issue/ Relevance to the project	Focus Areas for Engagement	Engagement Strategies	Tools, Methods and Frequency of engagement
Land acquisition and R&R Authorities	<ul style="list-style-type: none"> The acquisition of land for the project is led by the district and taluk level government authorities such as the District Collector, Deputy Collector, and Tahsildars. Expenses of land acquisition, compensation and R&R activities undertaken by these authorities are to be reimbursed by KMRL; Any claims for compensation or objections toward land acquisition or issues with awards issued or delays in payment of compensation are handled by this stakeholder group, making them a primary stakeholder group in the project. 	<ul style="list-style-type: none"> Transfer of expenses for execution of land acquisition process; Facilitation in identification of project affected persons and support during public hearings; Adherence to project schedule and timelines. 	<ul style="list-style-type: none"> KMRL being the Requiring Body in the project's land acquisition process, is required to make timely payments to this stakeholder group for them to carry out all functions of their job effectively and within the stipulated timeframe; KMRL had appointed third party consultants to facilitate the LA authorities to identify the project affected families based on available land data; The land acquisition process for S N Junction is in process and for Thripunithura terminal it is yet to start. KMRL could ensure that this stakeholder group is provided the necessary support to undertake this acquisition with minimum disputes generated. 	<ul style="list-style-type: none"> Make timely payment of expenses for land acquisition, compensation, R&R etc. Hire third parties for conducting valuation of assets or other studies for the project, as and when directed by the LA authorities; Remember the design changes that needed to be made to minimise impacts on community for Vadakkekotta and road widening and accordingly plan the property development, entry-exits of stations for S N Junction station and Thripunithura terminal; To re-direct persons with grievances and suggestions related to land acquisition/compensation to the LA authorities.
Other interested groups				<ul style="list-style-type: none"> There are other organisations interested in the project. Such as Kudumbashree, a government of Kerala organisation for eradication of poverty. The organisation has formed a Facility Management Centre to generate employment for the members of the community belonging to economically and socially disadvantaged groups.

8.7.9.6 Reporting and Review

The documentation of the stakeholder engagement carried out shall include the following key aspects:

- Total number of stakeholders KMRL engaged with;
- Geographical location of such engagement activities;
- Key concerns and risks identified and reasons for the same;
- Actions to address these concerns and report back to the people in the next engagement phase;
- Examples of how engagement has worked or where engagement needs strengthening; and
- Recommendations.

Summary of these details should be published on KMRL's website every quarter. These details should be included in the Annual Reports of the company.

8.7.10 Grievance Redress Mechanism

The grievance redress mechanism in link to the SEP provides a formal forum to the aggrieved or interested stakeholders to deal with issues arising out of environmental and social related issues linked to the project. The proposed Grievance Redress Mechanism (GRM) has been developed for the Project to promote amicable dispute settlement through mediation to reduce/avoid the escalation of such issues to litigation.

8.7.10.1 Context

The Kochi Metro Phase IA and IB project is partially under-construction. The land acquisition for the project started in 2017 and is ongoing for certain sections of the alignment. In this simultaneous pre-construction and construction phases of the project, need for grievance management is focused on the project affected entities and local community. The grievance handling followed for the project affected families is as per the process described in the Right to Fair Compensation and Transparency in Land Acquisition and Resettlement and Rehabilitation Act 2013. Whereas for the local community, KMRL has created a helpline and answers queries through RTI.

Although there is an existing helpline number, as the project transitions into construction and further into operations phase, there is a need for more formal grievance redress mechanisms for external stakeholders of the project.

8.7.10.2 Principles of Grievance Management

The GRM will abide by the following key principles:

- KMRL shall ensure proactive stakeholder engagement practices in order to avoid, wherever possible, a situation where a grievance may occur;
- Grievance mechanisms shall acknowledge and address concerns over both real and perceived impacts in the same way and with the same level of care;
- Grievance mechanisms shall address complaints, both formal and informal to avoid escalation into serious grievances;
- The engagement methods and mechanism will follow a transparent and easily understandable process along with access to several means of raising concerns;
- All grievance mechanisms that are put in place will incorporate the provision to raise concerns anonymously;
- No grievance mechanisms shall impede access to or seek to take the place of legal remedies, in case all the options are already exhausted; and
- All grievance mechanisms shall be readily accessible, culturally appropriate and proactively communicated to employees and other external stakeholders as appropriate.

8.7.10.3 Grievance categories

KMRL has formal grievance management system for some of the internal stakeholders such as employees and staff. However, the procedure for contractors, workers, and vendors is not formally defined. This GRM will address the concerns of the external stakeholders and some of the internal stakeholders as well. The grievances that KMRL will need to manage can be broadly categorised into the following:

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- Internal Grievances – contractors, sub-contractors, workers.
- External Grievances – project affected entities, local community, local government authorities, any other.

Examples of likely grievances of these stakeholders with respect to the project are as follows:

Internal:

- Risk to health and safety of the labourers or workers hired by the Contractors;
- Working condition of the labourers;
- Wage discrimination among the labourers;
- Timing of the payments;
- Adequate facilities in the labour camps (during construction stages) including water supply and sanitation;
- EPF, ESIC, Workmen's compensation, adequate health facility related issues;
- Unjustified deduction from the wages;
- Minimum wage rates for the labourers;
- Extended working hours;
- Prevention and protection of child labour from hazardous work condition;
- Issue of forced labour; and
- Gender discrimination.

External:

- Damage to land and infrastructure (both public and private);
- Eligibility issues and payment of compensation;
- Improper/ inadequate valuation of the compensation;
- Inadequacy of rehabilitation and resettlement provisions;
- Livelihood restoration issues and need for additional entitlements;
- Employment generation or the lack thereof; and
- Adverse impacts on common property resources;
- Impacts (noise & air pollution, accidents, vibrations) on health and safety due to project activities.
- Lack of pavement facility for pedestrians.

8.7.10.4 Structure of GRM

There will be a project-level Grievance Redress Cell (GRC) that will seek to resolve disputes arising out of various matters related to the implementation of the stakeholder engagement activities. The GRC will comprise of the following:

- Representatives of KMRL;
- Representatives of the Local Self Government (one from each LSG).

The GRC can be headed by KMRL's HR Manager. Key responsibilities of the GRC will include:

- Review, consider and resolve grievances related to social and environmental aspects received by the Project and its stakeholders mentioned above;
- Entertain grievances of indirectly affected persons;
- Resolve grievances within a period of two weeks at the GRC level and communicate the resolution to the aggrieved party;
- Arrive at decisions through consensus, failing which resolution will be based on majority vote. Any decision made by the GRC must be within the purview of Environmental and Social Management Plan, Stakeholder Engagement Plan, KMRL's EHS and Social Policies or any such documents relevant to that matter;
- In case the grievance relates to environmental monitoring results or engineering matters, the GRC will validate the information available to it, as provided by KMRL's project management team/ environmental monitoring team. However, GRC will not be able to question the validity of the data provided to it;
- The GRC team shall meet once in two months for review of grievances registered and the resolutions vetted out to the concerned parties. The frequency of meeting may increase or decrease depending on the number grievances received;
- Publish a summary of meetings on KMRL website;

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- If needed, may undertake field visits to verify and review the issues, dispute or other relevant matters.

Exclusions:

- The GRC shall not engage in any review of the legal standing of an ‘awardee’ nor shall deal with any matters pending in the court of law;
- The GRC will not prevent or prohibit access to legal redress that is enshrined in the judicial system of India.

8.7.10.5 Procedure of handling grievances

The Project proponent shall in the first instance and in order to avoid, wherever possible, a situation where a grievance occurs, shall ensure proactive stakeholder engagement practices and mitigation measures recommended in the Environmental and Social Management Plan (ESMP) of this ESIA.

Disclosure of GRM

The GRM structure, procedures, contacts of persons responsible, shall be disclosed to the local community, workers, contractors, and project affected entities. This can be done via multiple platforms, e.g. circulars given to LSGs, notices or graphs displayed at work sites and worker accommodations at conspicuous places, published on KMRL’s official website, or recorded as caller tune of the helpline number currently in use.

Receive and track grievances

This step primarily involves following stages:

- collecting and recording grievances as they come in;
- registering them in a central place; and
- tracking them throughout the processing cycle to reflect their status and important details.

Grievance registered, through any medium (helpline call, letter, verbal during a meeting etc.) should be collected at a central place and documented in a digitised or physical register.

Registration of the grievance shall include the following details:

- Name of complainant/ aggrieved (please give the option of anonymity)
- Grievance Reference Number,
- Grievance Category,
- Mode of communication-written/verbal/ meetings/ mediator,
- Date of Grievance received,
- Date of Acknowledgement sent,
- Concerned Department,
- Resolution Adopted,
- If delayed – reasons.
- Date of Resolution Executed,
- Status – Open/ Closed,

Every person registering the grievance through any medium should be given an acknowledgement within 24 hours of (working day) registration. The acknowledgement should be in a form of a digitised or physical receipt depending upon the mode of grievance registered. For example, if the grievance has been registered through a complaint letter, a response should be sent in a form of a letter within 24hours of a working day. If the grievance is registered through the helpline, a message of acknowledgement should be sent on the mobile number of the aggrieved. Preferably every grievance should have a Reference Number for ease of follow-up procedure.

If the grievance is related to the process of land acquisition, compensation, R&R the aggrieved should be re-directed to the land acquisition authorities. The response time for this remains 24hours.

Review and investigate grievances

A Single Point of Contact (SPOC) of the GRC shall review the grievance and decide if:

- it can be immediately resolved,

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- support from other departments of KMRL is required,
- an investigation is required for resolution.

In case of immediate response, the resolution should be executed within 2 weeks of the date of grievance registration.

In case other departments' support is required, the SPOC shall intimate the departments in written within 24hours of receiving the grievance.

Depending upon the severity of the grievance, an investigation can be triggered by the SPOC. The GRC should conduct a meeting for investigation within 2 days of receiving grievance. Persons of relevance from appropriate Department of KMRL or Local Government Body can be invited for the meeting. 80% GRC member attendance shall be mandatory for any investigation meeting.

Resolve or Prepare a response

- Grievance that can be immediately resolved – should be resolved within 2 days of receiving the grievance.
- Grievances that need support from other departments of KMRL – should be resolved within 10 working days.
- Grievances that deem an investigation – should be resolved within 26 working days.

The resolution should be communicated to the aggrieved and grievance shall be closed.

Any grievance resolution that takes longer period than mentioned above, can be escalated to the Company Secretary by the SPOC. The Company Secretary shall be briefed about the matter and the reasons for delay. After intervention of the CS, the grievance shall be resolved within 7 working days. If not, it shall be further escalated to the Board of Directors (BoD) after which the resolution should be provided within 7 working days.

Report and record

Summary of all grievances received, registered, documented and tracked should be reported in the quarterly reports submitted to higher management. This helps to keep track of overall trends and patterns of concerns allowing emerging issues to be flagged and understood at an early stage. The statistics on grievance handling and redress are to be included in action plans and annual reporting.

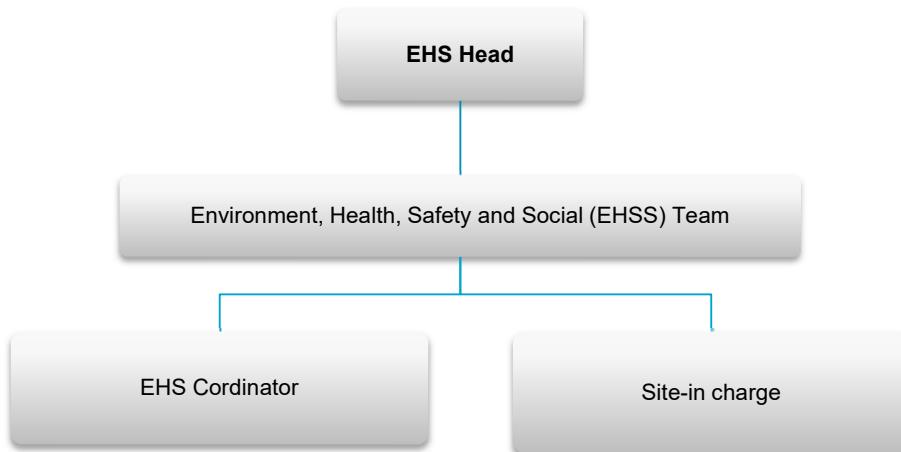
8.7.10.6 Monitoring

Monitoring and reporting can be tools for measuring the effectiveness of the grievance mechanism and the efficient use of resources. The Chief of Project Operations vertical can verify the status of all grievances every quarter and give inputs for improved performance to relevant departments and teams to minimise the occurrence of grievances. Moreover, the BoDs can also provide their feedback to the GRC based on the status of GRM given in the quarterly reports. Number of grievances received and resolved, and time taken to provide resolution can be important monitoring indicators.

8.8 Budgetary Provisions for ESMP Implementation

The ESMP implementation will not be successful without a proper designated team and financial support for the same. The proposed team for ESMP implementation is as given below. Adequate budgetary provision will be made by the KMRL for execution of environmental management plan.

The environmental budget for the various environmental management measures proposed in the EMP is presented in Table 8-10. There are several other environmental mitigation measures that have been addressed as part of good engineering practices, the costs for which have been accounted for in the engineering costs (Project cost). The design team has confirmed that the mitigation costs indicated in engineering cost are part of standard contract works. The budget for environmental management has been estimated to be INR 73,048,800.



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Table 8-10: EMP Budget

Sl. No.	COMPONENT	STAGE	ITEM	UNIT	UNIT COST (INR)	QUANTITY	Total Cost (INR)
(A) MITIGATION							
1.	Air	Construction	Dust management by water sprinkling/ spraying in the loading-unloading areas for construction material, earthwork, stockpile of the excavated material, unpaved haulage roads other dust prone areas and construction yard	km	-	-	INR 7,128,000
2.	Water	Construction	Fumigation and spraying of anti-mosquito breeding disinfectants at all the mosquito breeding locations	INR/Sq.m	-	-	INR 2,250,000
(B) MONITORING							
3.	Rainwater harvesting	Operation	Oil Interceptors at FACT casting yard and Muttoom depot areas	No.(Civil construction is not included)	1,50,000	2	INR 300,000
4.	Soil	Construction	Rainwater harvesting structures of suitable capacity along the alignment and at stations. The stations shall be provided with the facility of rainwater harvesting and artificial recharge.	lakhs per station	INR 3.5 Lakh	3 Stations	INR 1,050,000
5.	Green Belt Development	Operation	Cost towards solid and hazardous waste management on the site (average)	INR/Ton (direct landfill)	2000	40	INR 80,000
6.	Noise and Vibration	Construction and operation	Redevelopment of Casting Yard	Sqm	-	-	Included in Engineering Costs
			Development of Green Belt at Depot and other surplus areas available for the project.	INR			INR 4,000,000
			Protection devices (earplugs or earmuffs) shall be provided to the workers operating near high noise generating machines	INR	50	INR 10,000	INR 5,000,000
			Acoustic enclosures for DG sets and other construction equipment and machinery	INR	100000	Assuming all the 3 stations have DG set.	INR 300,000

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Sl. No.	COMPONENT	STAGE	ITEM	UNIT	UNIT COST (INR)	QUANTITY	Total Cost (INR)
7.	Tree Afforestation	Construction	Plantation including compensatory afforestation	INR/ Tree	2000.	2,000	INR 4,000,000
8.	Labour Camp	Construction	Organizing regular health check-up and immunization camps	INR	50000	10	INR 500,000
9.	Health and Safety	Construction/Operation	PPE provision	INR	3000	12,000	INR 36,000,000
			First Aid facility on site (First aid kit and first aid room)	INR		40,000	INR 40,000
					(A) Mitigation cost		INR 60,648,000
(B) MONITORING							
10.	Air Quality	Construction	Monitoring along the alignment as per Environment Monitoring Plan	No. of Samples	10,000	At 5 locations, once a month till construction period (3 Years)	INR 1,800,000
		Operation	Monitoring along the alignment as per Environment Monitoring Plan	No. of Samples	10,000	At 3 locations, Once a year for a period of 3 years	INR 1,080,000
11.	Water Quality	Construction	Drinking water quality monitoring at labour camps/ works site	No. of Samples	10,000	At 4 Locations	INR 720,000
		Operation	Monitoring along the alignment as per Environment Monitoring Plan	No. of Samples	10,000	At 4 locations	INR 640,000
12.	Noise	Construction	Monitoring along the alignment	No. of Samples		At 5 locations, once a month till construction period (3 Years)	INR 360,000
		Operation	Monitoring along the alignment at locations where monitoring was done during constructions	No. of Samples	2,000	At 3 locations	INR 120,000
13.	Ecological Monitoring	Operation					INR 10.00 Lakh

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SI. No.	COMPONENT	STAGE	ITEM	UNIT	UNIT COST (INR)	QUANTITY	(B)- Monitoring Costs	Total Cost (INR)
(C) TRAINING AND CAPACITY BUILDING and AUDIT								
1.	Training to Environmental Officer	Construction	Training to Environmental Officer for EMP Implementation	LS	150,000	External training to cover ESMP Implementation and capacity building	150,000	INR 4,820,000
		Operation	Training to Environmental Officer for EMP Implementation	LS	150,000	Inhouse/ external agency to prepare HIRA/HAZOP	150,000	
2.	Reporting	Construction	PPE inventory, skill matrix as per job safety assessment including HIRA/HAZOP	LS	6,00,000	Labour audit during construction Phase	6,00,000	
3.	Audit	Construction	Labour audit during construction Phase	Semi annually	2,00,000			
						(C)- Capacity Building	INR 1,300,000	
Summary of Cost								
						(A) Mitigation cost	INR 60,648,000	
						(B)- Monitoring Costs	INR 4,820,000	
						(C)- Capacity Building	INR 1,300,000	
						Total	INR 66,768,000	
						Contingency @ 10%	INR 6676800	
						Total Cost	INR 73,444,800	

9. Conclusions and Recommendations

Kochi Metro Rail Limited (KMRL) is a Special Purpose Vehicle (SPV) that has been formed by the Government of Kerala, for execution and operation of the proposed expansion of Kochi Metro phase I from Petta to Tripunithura. Extension of phase I measures 3.2 km in length and comprise of 3 stations, i.e. Vadakkekotta station, SN Junction station and Tripunithura terminal station.

All the applicable policies, rules and regulations by Government of India (GOI), Government of Kerala (GoK) and Indian Railways, requirements of the applicable framework and Safeguard Policy Statement from Asian Development Bank and other best practices have been considered for preparation of Environment Management Plan.

As per the current regulations of Government of India, Railway projects do not require conducting Environmental Impact Assessment (EIA) studies for obtaining Environmental Clearance (EC) under EIA Notification 2006. However, the proposed project falls under the preview of the Costal Regulation Zone, under CRZ II as per [Costal Regulation Zone Notification 18th January 2019](#) and CRZ clearance from Kerala State Coastal Zone Management Authority (KSCZMA) would have to be received.

An Environmental and Social Impact Assessment (ESIA) is carried out and the assessment is observed to have most of the adverse impacts of Proposed Metro Project during construction phase being temporary in nature. Most of these impacts can be minimized through specific engineering solutions, construction methodology incorporated in the Project design and by implementing mitigation measures as suggested in ESMP. During operation phase the project would have additional benefits on the economy, improvement in infrastructure, improvement in general mobility of the study area, reduction in fuel consumption and related environment impacts etc.

Environmental monitoring was undertaken for ambient air quality, ground and surface water quality, ambient noise levels, vibration analysis, soil quality and Ecological survey from the from the 6th to the 11th of November 2020.

Ambient Air Quality: Ambient air was monitored in the project area for the month of November to estimate the quality of ambient air around the project site. The air quality was analysed at Twenty-three (23) locations. The parameters measured for ambient air quality were noted to be within the permissible limits of the National Ambient Air Quality Standards (NAAQS), as defined by MoEF&CC.

Ambient Air Quality: The parameters measured for ambient air quality were noted to be within the permissible limits of the National Ambient Air Quality Standards (NAAQS), as defined by MoEF&CC. PM2.5, PM10, SO₂, and NO₂ were detected in all the samples but were noted to be well within the permissible limits, except PM10 at Kalamassery (Pre -cast yard), which was slightly above the permissible limit for October. The one-time exceedance maybe attributed to construction activities being carried out.

Ambient Noise Quality: The ambient noise levels at all locations along the alignment was noted to be exceeding the permissible standards of noise levels prescribed by CPCB for daytime and night-time. The high noise level can be attributed to vehicular movements along with ground levelling work being undertaken.

Ambient noise levels at NQ7 i.e. Eloor Casting Yard and NQ8 i.e. Irumpanam Stock Yard are within permissible standards of noise levels prescribed by CPCB for daytime. Ambient levels were found to be exceeding slightly above the permissible limits for night-time at NQ7. These exceedances are attributed to night-time operations of Eloor Casting yard.

Vibration: The vibration velocity at all locations is less than that recommended for dwellings and buildings of similar occupancy (5 mm/s), except for that measured at Milma diary. This location is classified as "commercial" and the maximum vibration velocity recorded here is less than that recommended for commercial establishments (20 mm/s).

Ground Water Quality: The pH value of the sample was observed to be lower than the prescribed range, indicating slightly acidic in nature. Other parameters were either within the permissible limit or below detection level, indicating that the drinking water was fit for human consumption, once it is treated for high pH with neutralizing media.

Surface Water Quality: The pH of surface water sample was within acceptable range. Odour was disagreeable. Total Hardness (As CaCO₃) and alkalinity were in the range of 740mg/l. Total Coliform was present in low numbers, meeting Standard for CPCB's Class C surface water guidelines. Mineral oil was not found. Pesticides were not found. Many metals such as Al, Mn, Ni, Cu, Boron, As, Se, Mo, Cd, Ba and Hg were below detection limit. All these parameters maybe used as baseline, to assess potential impacts to surface water body, during construction and operation phases.

Internationally Recognized Areas found nearest to the study area include:

Vembanad Kol Wetlands Ramsar Site

As per the map available on the RSIS, the proposed Project Site, as well as, the estimated Area of Influence (AoI) of the Project appears to be situated within the area designated as a Ramsar Site. However, the concerned map does not provide adequate geo-referencing to enable confirmation of the same.

Vembanad Lake KBA and IBA

As per the maps available on the KBA website and BirdLife Datazone, the KBA and IBA areas largely overlap each other and are situated approximately 1.7 km from the nearest point on the Project Site boundary.

Construction of the Project will involve use of various types of construction equipment that are mobile and with high intermittent noise emissions. Operation of the Metro will also lead to noise emission from movement of traffic. Appropriate mitigation measures have been proposed to reduce the impacts.

As the part of the study Environment and related Social, Health and Safety Management Plan (ESHSMP) has been prepared, based on the identified environmental attributes and type of the impacts. The main environmental attributes consist of air, water, noise and vibration, land, flora-fauna, occupational health and safety and environmental health and safety.

The ESMP implementation will not be successful without a proper designated team and financial support for the same. Adequate budgetary provision will be made by the KMRL for execution of environmental management plan.

Appendix A List of Documents Reviewed

Sr. No	Documents reviewed	Authority
1.	Contractor Agreement	KMRL
2.	SHE in Contract Documents	KMRL
3.	CTE for Casting Yard	KEC
4.	Environmental Management Plan	KMRL
5.	Environmental and operational Health &Safety (EOHS) Policy	KEC
6.	SHE Policy	KEC-CCECC
7.	Occupational Health, Safety & Environmental Plan	KEC-CCECC
8.	Operational Control Procedures	KEC
9.	Monthly EHS reports	KEC
10.	Legal Register	KEC
11.	Environmental monitoring records	KEC
12.	Emergency preparedness and response plans	KEC
13.	Hazard Identification Risk Assessment	KEC-CCECC
14.	Monsoon Management Plan	KEC
15.	Flood management plan	KMRL
16.	Annual Training calendar	KEC
17.	Traffic Management Plan	KEC
18.	Site Barricading Plan	KEC
19.	Site barricading Plan	KEC
20.	Utility shifting plan	KEC
21.	C&D and solid waste disposal agreement	KMRL
22.	MSDS for chemicals and materials	KEC
23.	Labour license and labour insurance	KEC-CCECC
24.	Tree Cutting Permission	KMRL
25.	Site Alternative study	KMRL
26.	Hydrogeology, sedimentation & flux study for Chembakkara Canal	KMRL
27.	Water supply agreements	KMRL
28.	labour license	
29.	PF license	
30.	Insurance for Labour	
31.	COVID guidelines and SOP	
32.	BOWC license	KEC-CCECC
33.	Contract Labour (Regulation and Abolition) License	KEC-CCECC
34.	Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) certificate	KEC-CCECC

Appendix B Stakeholders Consultation Detail

Sr. No.	Participants	Date	Venue	Mode of Consultation	Key Issues	Key Outcomes
1.	Mr. Srinivas Ms. Gayatri Ms. Jayanthi Mr. Raghav Mr. Swamy Mr. Swaminathan Ms. Chitra Other locals & daily travelers	02.11.2020	MG Road Cochin / Hotel Abad Plaza	Individual interview / FGD	<ul style="list-style-type: none"> KMR Project work Impact of construction Grievance Redressal Mechanism 	<ul style="list-style-type: none"> Initiative is well accepted among the locals Much needed project in the state/city Will facilitate daily commuting Service will save time and money Stations connecting important locations The stations and trains to be maintained well There is traffic congestion, that is bearable, managed well, locations need more safety signages Festival times need to be better managed, or may be the work is stopped for 2-3 days
2.	Mr. Thiruman Archunan, Director - Projects Mr. Kumar K R, Director - Finance Mr. Vinu C Koshy, GM(Projects) Mrs. Seenii Alex, Addl GM (F&A) (Finance - Coordinator for ADB team) Mr. Rizwan T, Manager (Civil) (Projects - Coordinator for ADB team)	03.11.2020	KMRL Office	FGD	<ul style="list-style-type: none"> Project information Status of project R&R Approach Project land Other issues impacting on Project Grievance Redressal Mechanism 	<ul style="list-style-type: none"> LARA Act 2013 (replace with proper abbreviation in all such places) was strictly followed for land acquisition Land acquisition for Phase 1B is waiting for administrative sanction. Local Body Election 2020 will not have any impact on the ongoing project/work, if at all, it will be for 15-20 days only. Quantum of land acquisition was huge for road widening work. There are PAPs impacted twice due to the project. There was no unclaimed land falling in the required land for the project KMRL is the owner of viaduct and stations only, for other properties the ownership is only to the extent of project duration. Permission from GoK has been obtained for ROW NH has given permission in principal for viaduct construction.

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Sr. No.	Participants	Date	Venue	Mode of Consultation	Key Issues	Key Outcomes
1	Mr. Jishu, Legal Officer Mr. Iyer, Land Acquisition Officer	03.11.2020	Road Stretch, Tripunithura	FGD	<ul style="list-style-type: none"> Project Information Provision at Site & Camp Other facilities Challenges & problems faced 	<ul style="list-style-type: none"> Land from Railways also to be procured, agreement in process, as per Railway Policy it will be on lease for 75 years. There are properties taken on rent by KMRRL, for instance, at Kalamassery for Casting Yard and labor camp. LA and compensation related grievances are settled as per LARA Act.
3. Site Engineers, Contractors, Labors	03.11.2020	Road Stretch, Tripunithura	FGD	<ul style="list-style-type: none"> Challenges & problems faced 	<ul style="list-style-type: none"> There are some locations where access / ROW is temporarily blocked, an alternate passage has been provided. In case of emergency the work is stopped, and passage cleared During accident and medical emergency cases at the construction site, there is tie-up with VKM Hospital and KEC Int. Ltd, which is open 24x7 Labors are from Bihar, Jharkhand, WB There are 25 labors working at site. Activities going on at the site for 24 hours, there are two shift duties from 0800 hours to 2000 hours and vice versa. Accommodation at a labor camp, at 25 kms distance Meal ration is provided by the contractor, but labors cook themselves. Camp site has drinking water facilities, proper toilets and bathing areas. Labors get pick up / drop off facility 	<ul style="list-style-type: none"> The construction site has no rest shelter, drinking water and toilet facility. They go to nearby restaurant. First aid box wasn't available at construction site Not aware of any training programs, on safety issues or any other There is constant traffic noise, dust flow and vibrations due to heavy machine functioning.

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Sr. No.	Participants	Date	Venue	Mode of Consultation	Key Issues	Key Outcomes
4.	Mr. Biju, Shop Manager (Mr. Manoj K, Owner – Ph 9895090615)	03.11.2020	Shop - Bajaj Popular, Tripunithura	Interview	<ul style="list-style-type: none"> About KMR Project Impact due to the work LA and R&R issue Grievance Redressal Mechanism 	<ul style="list-style-type: none"> Happy that such a project is happening in Kochi. Part of the shop land had to be given away, compensation fully paid. No grievances regarding compensation & payment
5.	Mr. Raghu, Restaurant Owner – Ph. 8129769222	03.11.2020	Ayyappas Brahmins Hotel, Tripunithura	Interview	<ul style="list-style-type: none"> About KMR Project Impact due to the work LA and R&R issue Grievance Redressal Mechanism 	<ul style="list-style-type: none"> Happy about the upcoming project, good for people Does not remember how much land was given and the compensation amount received, though happy with the amount received. Due to the construction work there are vibrations and that is the problem With the start of the construction work, congestion and no parking less people come to restaurant, the business has gone down drastically.
6.	Ms. Prema & Mr. Chettanadam, Local Residents - Ph 8921869266	03.11.2020	Residence, Tripunithura	Interview	<ul style="list-style-type: none"> About KMR Project Impact due to the work LA and R&R issue Grievance Redressal Mechanism 	<ul style="list-style-type: none"> Metro rail service will be very good for daily commuters. LA area was one (01) cent. Received 31 lakh as compensation amount. In the one cent area there was boundary wall, lights and part of septic tank In 2017 the land area assessment was done and in 2019 compensation amount received. Not happy with the amount
7.	Ms. Sheela, Traffic Inspector, KMRL Contractor - KEC	03.11.2020	Road Stretch, Tripunithura	Interview	<ul style="list-style-type: none"> About the project Job of Traffic Inspector Provisions at work site 	<ul style="list-style-type: none"> The project – Metro Rail facility will be good for Kochi people. No objection from family vis a vis the job. People do obey her instructions Gets INR 400 per day for six (06) hours duty, from 1400 hours to 2000 hours. Happy with the job, though six hours in heavy traffic and noise pollution becomes tiring. Comes in her scotty, brings water from home. No toilet provision uses toilet in a tea shop nearby. No other benefit from the company.

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Sr. No.	Participants	Date	Venue	Mode of Consultation	Key Issues	Key Outcomes
8.	Ms. Nisha M, Traffic Inspector, KMRL Contractor – KEC Ph 9526778966	03.11.2020	Road Stretch, Tripunithura	Interview	<ul style="list-style-type: none"> About the project Job of Traffic Inspector Provisions at work site 	<ul style="list-style-type: none"> No contract signed, no insurance policy. Has been working for few months now, no health problems. No training or orientation to traffic management, instructions were given to her. At the time of any chaos, congestion and/or accident, she has to contact the site in-charge.
9.	Dr. Mathew, Proprietor, Verma Hospital	03.11.2020	Road Stretch, Tripunithura	Interview	<ul style="list-style-type: none"> About KMR Project Impact due to the work LA and R&R issue Grievance Redressal Mechanism 	<ul style="list-style-type: none"> Kochi people are happy with the new development – Metro Rail Family members have no problem with her working as a traffic inspector. Generally, people obey except few miscreants. No training or orientation to traffic management, instructions were given to her. Bring water and food from home. No toilet facility, used Verma Hospital, that is at about 50 m distance Monthly salary INR 12000/- Working hours from 1400 hours to 2000 hours 1600 hours to 1800 hours is the peak period when traffic chaos is at its height No health problems so far No other provisions/benefits provided by the company No contract signed, no insurance policy. At the time of any chaos, congestion and/or accident, she has to contact the site in-charge.

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Sr. No.	Participants	Date	Venue	Mode of Consultation	Key Issues	Key Outcomes
10	Mr Sibby, Staff Milma (Seller at the sale counter), Mr. Hari, Product buyers, Mr. Shaji and others at the parlor	03.11.2020	Milma Parlor Ernakulam Dairy Gate, Tripunithura	Individual interview / FGD	<ul style="list-style-type: none"> About KMR Project Impact due to the work LA and R&R issue Grievance Redressal Mechanism 	<ul style="list-style-type: none"> KMRL is doing good job and managing project activities with well, with safety and security. There is traffic management in time of hospital emergency cases. Parking for vehicles has become a problem. An area (area could not be indicated) of the parlour has been taken by KMRL. That had the guard room on it. KMRL after land acquisition will build the guard room as well. Compensation for the land has also been paid. People in the city happily welcome the Metro Rail project. The entire stretch remains busy the whole day, some planning should be done to reduce the traffic chaos & congestion. There is regular sprinkling of water that restricts dust flow. The work has reduced parking space all along the stretch. Construction work didn't impact negatively on sale at the parlor, rather has increased per day sale.
11	Labor at Site near Milma Parlor	03.11.2020	Road Stretch, Tripunithura	Interview	<ul style="list-style-type: none"> Provision at Site & Camp Other facilities Challenges & problems faced 	<ul style="list-style-type: none"> Have come from West Bengal, family is in the native village. Accommodated in the labor camp, with provisions of drinking water, proper clean toilet, bathing area. Wage amount INR 450 per day, get it as monthly salary, do get advance money when required. No awareness on COVID 19. Work site has no drinking water and/or toilet facilities. Not aware of any training on safety at work site or any other social/environmental issues. For any grievance issue contact the site in-charge. No grievance issues so far. Happy with the provisions at the labor camp site and work site.

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Sr. No.	Participants	Date	Venue	Mode of Consultation	Key Issues	Key Outcomes
12	Ms. Vidya, Ms. Parvathi, Ms. Seema, Ms. Revathi + 2 - Local Students	03.11.2020	Road Stretch, Tripunithura	FGD	<ul style="list-style-type: none"> About KMR Project Project management Any grievances 	<ul style="list-style-type: none"> It will be a boon to city travelers. It should have smart card system like in Delhi-Gurgaon and student pass system. There is often traffic jam, though not for very very long, it clears after some time. Not heard of major accidents due to the construction work. There should have been some kind of community consultations with city people for decision on station locations.
13	Mr. T Babu & Mr. T Ramesh, Local Residents	03.11.2020	Road Stretch, Tripunithura	Interview	<ul style="list-style-type: none"> About KMR Project Project management Any grievances 	<ul style="list-style-type: none"> Happy for such a step by GOK Much needed project, no resentment for the project, there may be grievance cases concerning land issue. Project management team is managing the project well.
14	Ms. Anjana Rajesh, Manager (Civil) Casting – Ph 7356602802, Mr Maneesh, Site Safety Officer – Ph 79567882464, Site Engineers, Contractors, Labors	03.11.2020	Casting Yard	Individual interview / FGD	<ul style="list-style-type: none"> Place of domicile Provisions at site Wages / salary Trainings and welfare programs at site On safety, health & sanitation measures Grievance redressal mechanism 	<ul style="list-style-type: none"> Land is taken on rent from Fertilizers and Chemicals Travancore Limited (FACT), a public sector undertaking, GOI Land was taken on lease from 2013 to 2015, meetings were held was extending the lease period till Oct 2022, lease renewal and preparation of Agreement document is in process. The total area of land on lease is 04 hectares, 2.5 hectares for 1A and 1.5 hectares for 1B A rent of amount INR 67.88 lakh per hectare is paid annually. As per the lease conditions, the land parcel will be restored to the best possible extent by the leasee. Construction work of Phase 1A from Petta to SN Junction is being managed by a Joint Venture Company – KEC and CCECC. And, construction of Phase 1B from SN Junction to Tripunithura being managed by KEC and VNC Company. There are training programs held every day for 15 minutes from 0830 hours to 0945 hours. Trainings have been on – building safety, welding safety, lifting heavy

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Sr. No.	Participants	Date	Venue	Mode of Consultation	Key Issues	Key Outcomes
15	Ms. Amirtha Vally A, Deputy Collector – Ph 99447978545 Mr. Mustafa Kamal, Special Tehsildar – Ph 6238182305, Mr. P Sindhu, Special Tehsildar – 9446802778, Ms. Bindu Rajem, Jr Superintendent – Ph 7559840554 and Mr. Biju KD, Sr Clerk – Ph	04.11.2020	Land Revenue Department	FGD and telecon	<ul style="list-style-type: none"> National and State Land acquisition Policy The procedure of LA and R&R Grievance issue management 	<ul style="list-style-type: none"> The LA office is strictly following the LARR Act 2013 for settling R&R issues and paying compensation to PAPs and the land acquisition. Formal notification served by GOK is the cut-off date. All affected are categorized as PAPs, there is no separate category of vulnerable PAPs. There are no gender desegregated data. Based on the approved project design, SIA is carried out, outsourced to agencies/institutions, such as Bharat Mata College, Kerala Voluntary Health Services, Rajgiri College of Social Sciences etc. Government notification is issued informing locals for land acquisition and R&R issues. There is a definite consultation & disclosure procedure followed in the land acquisition and R&R matters.

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Sr. No.	Participants	Date	Venue	Mode of Consultation	Key Issues	Key Outcomes
0847259989, Mr. Subramanium Iyer, LA Officer – Consultant, KMRL					<ul style="list-style-type: none"> There is declaration award enquiry where Detailed Valuation Statement (DVS) papers, signed by collector is presented in the discussion forum, shared with PAPs To calculate the land value, cost considered is double the present market value along with last three (03) years average. There had been individual meetings with PAPs, and public meetings/hearings were organized to listen to grievances and demands of affected public. As part of LA process relevant documents are requested from the PAPs, when furnished, on verifying the reliability & validity of documents and verification from village records/ corporation records, the compensation amount is deposited in PAPs a/c. Instances of incomplete documentation and stay due to litigation the compensation amount is deposited at DC office. One time payment is made to PAPs, there is no monitoring of their (PAPs) re-establishments. There is no separate shifting assistance, it is covered in the solatium paid to PAPs. A formal document like RAP is not prepared, though the entire process is filed with list of PAPs, consultations/meetings held, compensation amount, etc. People – owners/rentee/others fall in the category of PAPs, only if they are residing/occupying the place for three (03) or three plus (03+) years. People staying for less than three years do not get any compensation/solatium. No compensation paid to encroachers and non-titleholders, only livelihood compensation is paid, if stationed at the location for three or more than three years. There are different livelihood restoration packages for PAPs. Package of INR 6,10,000 to rentee and INR 5,50,000 to owners. 	

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Sr. No.	Participants	Date	Venue	Mode of Consultation	Key Issues	Key Outcomes
16	Mr. ENL Memon, Owner HP Petrol Station – Ph 9447780970 and Ms. Shobhana, Manager	04.11.2020	Petrol Station at Tripunithura (SNJ Station Location)	Telecon and individual interview	<ul style="list-style-type: none"> About the metro project LA & R&R issues Impact of construction work Grievance issue management 	<ul style="list-style-type: none"> No R&R package is provided to PAPs, if residing/occupying more than 3000 sq feet area. In case of compensating for commercial set up, it must be the primary source of income, then only livelihood loss is compensated. No compensation if PAP has alternate or more than one source of income. In case of temporary acquisition, the area (space) is restored back to best possible extent while returning to the owner. If the person/PAP is not available, LA authority waits for sometimes, maximum wait for three (03) years. After that the assessment is done and the prescribed compensation amount is deposited at DC office. There is no internal and/or external monitoring of land acquisition and R&R after the compensation amount is paid, the process is closed. For acquiring common properties, the compensation is paid to the concerned authority. Grievances concerning land acquisition and compensation are settled by LARAA authority. Has been attending grievance issues in public hearings as well. Grievances/complaints can be put up in writing at DC office or by sending mails addressed to DC. The complainant anyhow has complete freedom to approach the court of law at any point of time. There is a public grievance portal, where any complain can be registered.

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Sr. No.	Participants	Date	Venue	Mode of Consultation	Key Issues	Key Outcomes
17	Ms. Lizzy, owner's aunt (owner Mr. Thankamma – Ph 8893801633)	04.11.2020	Store at Tripunithura	Individual interview	<ul style="list-style-type: none"> About the metro project LA & R&R issues Impact of construction work Grievance issue management 	<ul style="list-style-type: none"> No calculation of compensation amount has been conveyed to the owner; nothing has been paid to him. Conveyed that the calculation of compensation amount is in process. Owner has been conveyed that he has to vacate the land by end of Dec 2020. Owner, on his own has located another (alternative) site for petrol station, licensing procedure is in progress. Annual turnover is around 12 crore and owner earn around 100,000 per month (after COVID pandemic) and earlier it used to be 250,000 to 300,000 per month. For manager, her salary is secondary source of income for the family. Manager aware of land acquisition, change of location and possible loss of job, though temporary. She gets around INR 03.25 as commission for per liter sold. Probably will be reinstated in the same position by the owner in new location.
18	Mr. Jayanth KB and Ms. Latha Jayanth, Restaurant Owner – Ph 9847155333	04.11.2020	Chinnus Restaurant at Tripunithura	Individual interview	<ul style="list-style-type: none"> About the metro project LA & R&R issues Impact of construction work 	<ul style="list-style-type: none"> Good that city will have Metro Rail Service No major problem, just that roads have become little narrow and that creates problem – traffic congestion particularly during rush hours. Around ½ cent of land is to be acquired, compensation probably not paid. He is searching for alternate location to start new business. This one is a general store, want to change the nature of business. Want to know how the authority is calculating the compensation amount.

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Mr. P N Balakrishnan - 6238484188				Grievance issue management	<ul style="list-style-type: none"> Had two (02) daughters, both are married. Hindu general Nair caste. Part of restaurant renovation work was done by them, that incurred a cost of around 5-6 lakh was spent. Taken the shop on lease, that expired five years back, not yet renewed. Had paid INR 4 lakh in the beginning, and pays INR 15,000 per month, in addition pay INR 3000 per month for electricity and INR 1000 per month as water charges. 	
19 Mr. Devdas, Shop Owner – Ph 9495819398	04.11.2020	Shop at Tripunithura	Individual interview	<ul style="list-style-type: none"> About KMR project LA & R&R issues Impact of construction work 	<ul style="list-style-type: none"> Connectivity through train within city is good. 40 years old, runs a family of four, only earning member for the family, sells coconut, this is the only source of income. By caste he is Hindu Kudumbi, OEC Only information shared is that (part) of shop will be acquired for the KMR project, and due compensation will be paid. Assessment on acquisition is being carried out, that will be followed by compensation amount calculation. He earns around INR 35,000 to 50,000 per month. Eager to know quantum of acquisition and compensation amount. 	
20 Mr. Sujo, Sales Manager – Ph 9744940079 and Mr. Ruben, Owner – Ph 9562196060	04.11.2020	Garment Shop at Tripunithura	Individual interview and Telecon	<ul style="list-style-type: none"> About KMR project LA & R&R issues Impact of construction work 	<ul style="list-style-type: none"> Project is a good initiative, needed in Kochin Area to be acquired from this property is around one (01) cent. Shop owner has taken the property on rent, paying INR 10,000 per month, he is Hindu OBC. He has renovated the structure, spending an amount of 8 lakh. There are two (02) sales managers, working in this shop is their only income. He got the information by word of mouth that area is required for KMR project, but no one yet has approached him. 	

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21	Mr. Priyesh Francis, Mr. Akshay AS, Mr. Bablu Alam - Labors	04.11.2020	Construction site - Tripunithura	FGD	<ul style="list-style-type: none"> • Provision at Site & Camp • Other facilities • Challenges & problems faced 	<ul style="list-style-type: none"> • There has been no meeting discussion on selling/buying and compensation amount. • Priyesh is Christian and a local habitant, Akshay local and Hindu by religion, Bablu a Muslim is from Bihar. • All three working in this project for 3-4 months, are involved in fabrication work. • Bablu staying in a rented accommodation, paid by the contractor. • They bring their own drinking water, there is no toilet facility. • During mealtime or resting they sit under the structure being constructed. • They have never witnessed any training on work safety or any other issues by the contractor. • Get their monthly salary on time, partly keep for self and partly for home/family consumption. • No idea/understanding of saving for future or investments, would like to have awareness on the same.
22	Mrs. Asha Balan & Mr. Balan, Local Resident	04.11.2020	Footpath - Tripunithura	Individual interview	<ul style="list-style-type: none"> • About KMR project • Construction work • Grievance issue management 	<ul style="list-style-type: none"> • The metro rail project is a boon to people in Kochi. • There is traffic congestion due to construction work, that too mainly at Pettai area. • Parking near religious structures is totally/partially gone, this creates lot of problem • Parking is also a problem at the market area in Poonithura • Never had any issue to go and complain at KMRL office
23	Mr. Santosh, Temple Manager – Ph 0484 2774007	04.11.2020	Temple premise	Individual interview	<ul style="list-style-type: none"> • About KMR project • Construction work • Grievance issue management 	<ul style="list-style-type: none"> • Temple is 100 years old, Bhadrakali Temple, is 1½ kms away from the Vanakkemba station. • Around 200-300 people visit temple every day, due to COVID the number has reduced to 100. • The temple has employed around 100 men, no women work in the temple. • Festival time is mid-November, devotees number goes up to 25000-30000 each day for a week at least.

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24	Mrs. Ajimal, Bakery Shop Owner	04.11.2020	Bakery	Individual interview	<ul style="list-style-type: none"> About KMR project LA & R&R issues Impact of construction work Grievance issue management 	<ul style="list-style-type: none"> Last year local administration was involved to manage the crowd during festival time. Feel happy for the upcoming metro project, it will ease life of daily travellers Kochi people are happy and welcome this project. It's a rented property, Pays INR 7000/- as rent per month. She is an OEC by caste, and runs the bakery, her only source of income. Husband sells lottery, two sons studying. She earns INR 50,000 per month. Has received livelihood compensation, does not remember amount but is happy on whatever she has got.
25	Father, St. Joseph Church	04.11.2020	Church premise	Individual interview	<ul style="list-style-type: none"> About KMR project LA & R&R issues Impact of construction work Grievance issue management 	<ul style="list-style-type: none"> The church is around 20 m away from the Vadakkekkota Station. Loss of land measured 1.25 cents, compensation amount received, accepted and happy. Project had spent on shifting statue and renovating its base, located on left side of the entrance gate. During construction work drilling gives lot of vibrations, and the noise pollution. Congregation on all Wednesday account for 7000 people, on Sundays around 60000, during Christmas time its countless. Now a days only 20-25 people come.
26	Mosque caretaker	04.11.2020	Church premise	Individual interview	<ul style="list-style-type: none"> About KMR project LA & R&R issues Impact of construction work Grievance issue management 	<ul style="list-style-type: none"> The mosque 100+ years old, had to give away ½ cent land for the project. The mosque runs a madrasa in it, around 45 children attend. This had the mosque parking area, and that is totally gone, due to no parking area and the location being at the edge of the road, less people come there. The compound wall also totally gone. Around 30 m long, the wall will now cost INR 50,000/-

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Sr. No.	Participants	Date	Venue	Mode of Consultation	Key Issues	Key Outcomes
27	Mrs. Mercy & Mr. Peter, Resident	05.11.2020	Chambakkaran Fishermen's Colony	Individual interview	<ul style="list-style-type: none"> About KMR project Construction work Grievance issue management 	<ul style="list-style-type: none"> All Fridays there used to a gathering of around 350 people, now a days 50-75 only. Happy with the compensation amount received. The disturbance, particularly vibrations due to heavy vehicular movements.
28	Mrs. Sujitha, Resident	05.11.2020	Chambakkaran Fish Market	Individual interview	<ul style="list-style-type: none"> About KMR project Construction work Grievance issue management 	<ul style="list-style-type: none"> Fishermen by profession, living there for 20+ years. Truck parking due to construction work was restricted. Work was carried out only at nighttime, there was noise pollution due to vibrations for nearly six months. There was no negative impact on livelihood. Did not know where to go for complaint, finally approached KMRL, but after few days the work was complete Catching fish and selling is the only source of income. OEC by caste, living in the area for 15+ years. No negative impact due to metro construction work, but parking in the area was disturbed Less number of people were coming, that affected their selling, though not very significant Never thought of complaining to authorities
29	Mr. Babu, Shop Owner	05.11.2020	Chambakkaran Shop	Individual interview	<ul style="list-style-type: none"> About KMR project Construction work Grievance issue management 	<ul style="list-style-type: none"> General store owner (with bakery items and tea), the only source of income No problems experienced due to metro construction works Tea selling had gone up, along with bakery items. Due to construction work there was parking problem for the trucks to load/unload fish Introduction of KMR is a boon for the city
30	Mrs. Ragamal & Mr. Guruswamy, Vendors	05.11.2020	Chambakkaran Shop	Individual interview	<ul style="list-style-type: none"> About KMR project Construction work Grievance issue management 	<ul style="list-style-type: none"> Both husband & wife are lottery seller, only source of livelihood Earns about INR 1500 a week No negative impact due to the project work People talking good about the KMR project

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31	Mr. Ali K. Ms. Aziza, Mr. Naushad, Ms. Shahina + 2 – all vegetable vendors	05.11.2020	Chamakkaran Shop	FGD	<ul style="list-style-type: none"> About KMR project Construction work Grievance issue management 	<ul style="list-style-type: none"> All are vegetable & fruit sellers, none have any alternate source of income Have been selling on the footpath for nearly six years There has been no problem due to the construction work The metro rail service will be good for Kochi people
32	Mr. P A Diwakaran, Secretary Temple Trust	05.11.2020	Vaishnawa Gandharva Swamy Temple Chamakkaran	Individual interview	<ul style="list-style-type: none"> About KMR project Construction work Grievance issue management 	<ul style="list-style-type: none"> Had to give away land area measuring 30-32 m2. Received the compensation amount of INR 16,00000/- Planning for temple renovation with the amount received. Parking area at the temple front is totally gone, people park vehicles at the back side of temple, there is often congestion As the parking area has reduced, there is decrease in number of devotees coming, those who come can't stay long as parking for long on the roadside is not allowed.
33	Mr. Manilal, Resident/Restaurant Owner	05.11.2020	Residence Chamakkaran	Individual interview	<ul style="list-style-type: none"> About KMR project Construction work Grievance issue management 	<ul style="list-style-type: none"> Had to forego land area, small portion. Property is residence cum restaurant. Has received the compensation amount and is happy. No impact on the restaurant and daily earning. Had to keep the restaurant closed for six (06) months. Alternately provides taxi services, earns 20,000/- a month Has a family of four (04) members, daughters study in school Temple parking is extended to the temple back side, which often creates traffic chaos. Metro rail service is most welcomed
34	Mr. Soman, Fisherman, Local resident	05.11.2020	Residence Chamakkaran	Individual interview	<ul style="list-style-type: none"> About KMR project Construction work Grievance issue management 	<ul style="list-style-type: none"> Fisherman by profession, has no alternate source of income There are debris in the water, moving boats becomes problem, particularly in low tide No fish means no earnings for that day Metro rail service will be good for Kochi people

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Sr. No.	Participants	Date	Venue	Mode of Consultation	Key Issues	Key Outcomes
35	Mr. Jai Prakash & Mrs. Premila, Resident & Owner of Vinayaka Restaurant	05.11.2020	Restaurant Chambakkaran	Individual interview	<ul style="list-style-type: none"> About KMR project Construction work Grievance issue management 	<ul style="list-style-type: none"> Parking area of the temple is gone, people come and part at the backside, near our residence. There is often blockade due to less space n more vehicles parked Metro service in the city is very much welcome Lost part of land for the project (3.25 cents), received compensation amount of INR 76,00000/- Had borrowed money from relatives, loan amount now paid Restaurant area 606 sq.feet now renovated, house on 867 sqfeet also renovated Had to stay in a rented accommodation for two (02) years
36	Mr. V P K Panicker, Advocate, Ph 9447434191	05.11.2020	Online	Questionnaire	<ul style="list-style-type: none"> About KMR project Construction work Grievance issue management 	<ul style="list-style-type: none"> Came to know about KMR project through newspaper Initially locals didn't accept the idea of MR project, there was hue n cry over land acquisition Total property acquired for project, 0.90 acres of property-residential building was notified for acquisition in 2013 & property measuring 1.12 Acres (2.76 cents), also had office premise was notified for acquisition in 2018 Land along with structure was acquired, no shifting assistance provided Had to look for new locality/area for office & residence Compensation amount partly paid, and part is pending, the amount calculated was double the market rate. Not happy with the compensation amount, have appealed to the court, case yet to be settled. Grievance issue – Land value fixed ignoring documents showing actual market value. Structural value fixed is low, RR Package is inadequate. No compensation for loss/ diminution of avocation."
37	Mr. Ani George, Head Mistress, St	05.11.2020	Online	Questionnaire	<ul style="list-style-type: none"> About KMR project Construction work 	<ul style="list-style-type: none"> The project is well accepted and appreciated. Land area acquired is 4.36 Acres (10.773 cents), belongs to the Convent

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George School & Sr. Liza				Grievance issue management	<ul style="list-style-type: none"> Not happy with the compensation amount calculated, under litigation, amount yet to be paid. LARAAN not strictly followed, no solatium paid School parking area is lost, people/parents/teachers face problem during school meet/functions etc. After road construction there has been problem in the drainage system, water flows inside the school, this needs to be rectified. The authorities have forgotten to put a speed breaker near the school building, heavy traffic keep passing through in a very high speed, this may cause accidents. School has complained about these, but no response. 	
38Local people	Kappala at Poonithura	05.11.2020	Observation & FGD	About KMR project Construction work Grievance issue management	<ul style="list-style-type: none"> Metro rail service is well accepted by Kochi people, though initially there were doubts on land acquisition and compensation This area had residential structure, Milma Milk Parlor and the Kappala – except Kappala structure, all other structures gone. The land was acquired for metro track and road widening work Kappala to be preserved at the site by the project authority. The site had no project information board or any security signages People come near the Kappala to offer prayers, walking through the debris 	

Appendix C Stakeholder's Attendance Sheet

Attendance Sheet			
SN	NAME	DESIGNATION	CONTACT
1	Kurien	Mr. PMG	9574760618
2	Dossen	Mr. PMG	8548606186
3	Arun	Mr. PMG	9561562664
4	Chandy	Mason	6296775757
5	John Doss	Mason	9599630762
6	Sajin	Mr. PMG	7304128469
7	Sanjay	Mr. PMG	7305162367
8	Saparath	Mr. PMG	7321974830
9	Sajin	Mason	9016571164

Labours available during consultation at Casting Yard Labour camp

Attendance Sheet			
SN	NAME	DESIGNATION	CONTACT
1.	Anitha Vally Amal	Deputy Collector	9447978545
2.	Mathew Kurian	Asst. Collector	6238182305
3.	P. Sardan	Asst. Collector	9446802778
4.	Rima da Rajan	Tourist Development	75559840554
5.	Rajiv K.D	Mr. Clerk	9847259989

Land Revenue Officials present at the Meeting

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