



**ASIAN INFRASTRUCTURE
INVESTMENT BANK**

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**Project Document
of the Asian Infrastructure Investment Bank
Sovereign backed Financing
Republic of India
Chennai Metro Rail Phase 2 - Corridor 4 Project**

Currency Equivalents

(As of April 23, 2021)

Currency Unit – Indian Rupee (INR)

INR1.00 = USD0.0133

USD1.00 = INR75.01

Borrower's Fiscal year

April 1 – March 31

Abbreviations

ADB	Asian Development Bank	IGBC	Indian Green Building Code
AIIB	Asian Infrastructure Investment Bank	INR	Indian Rupee
AFC	Automated Fare Collection	IOCT	International Open Competitive Tender
BIM	Building Information Modeling	JICA	Japan International Cooperation Agency
BOQ	Bill of Quantities	MMI	Multimodal Integration
CAAA	Controller of Aid Accounts and Audit	MoU	Memorandum of Understanding on Cofinancing
CMA	Chennai Metropolitan Area	NUTP	National Urban Transport Policy
CMDA	Chennai Metropolitan Development Authority	NDB	New Development Bank
CMRL	Chennai Metro Rail Limited	OCC	Operation Control Center
CRZ	Coastal Regulation Zone	O&M	Operations and Maintenance
DDC	Detailed Design Consultant	PAF	Project Affected Families
DPR	Detailed Project Report	PAP	Project Affected Persons
E&M	Electrical and Mechanical	PDS	Project Delivery Strategy
EIA	Environmental Impact Assessment	PPM	Project-affected People's Mechanism
EIRR	Economic Internal Rate of Return	PWDs	Persons with Disabilities
EMP	Environmental Management Plan	RP	Resettlement Plan
ES	Environmental and Social	SIA	Social Impact Assessment
ESP	Environmental and Social Policy	SCS	Shadow Cash Support
ESS	Environmental and Social Standards	TVS	Tunnel Ventilation System
GC	General Consultant	USD	United States Dollar
GHG	Greenhouse Gas	VAC	Ventilation and Air-conditioning
Gol	Government of India	VOC	Vehicle Operating Cost
GoTN	Government of Tamil Nadu	VOT	Value of Time
GRM	Grievance Redress Mechanism	WB	World Bank

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1. Summary Sheet

Project No.	000301
Project Name	Chennai Metro Rail Phase 2 - Corridor 4 Project
AIIB Member	Republic of India
Borrower	Republic of India
Project Implementation Entity	Chennai Metro Rail Limited (CMRL)
Sector	Transport
Sub-sector	Urban Rail
Project Objective	To provide increased capacity and efficiency of east-west connectivity by expanding the Chennai metro system.
Project Description	<p>The Project (Corridor 4) spanning from Lighthouse (in the east) to Poonamallee Bypass (in the west) has a length of 26.8 km, of which 16.5 km is elevated, and 10.3 km is underground, with 18 and 12 stations, respectively. The Project will be co-financed in parallel by AIIB, ADB, and NDB.</p> <p>The Project component to be financed by AIIB under the proposed Project are:</p> <ul style="list-style-type: none"> - Component A: Construction of 16.5 km of the elevated viaduct, including 18 elevated stations <p>The remaining Project components and their financing sources are as follows:</p> <ul style="list-style-type: none"> -Component B by ADB: Construction of 10.3 km underground section, including 12 stations. -Component C by NDB: E&M works, tunnel ventilation system, telecoms, AFC, platform screen doors, traction, power supply. -Component D by Government of Tamil Nadu (GoTN): General Consultant, signaling, rolling stock, depot and staff quarters, permanent way, security features. -Component E by GoTN: The consolidated Project land, R&R, and state taxes.
Implementation Period	Start Date: July 1, 2021 End Date: December 31, 2026
Expected Loan Closing Date	March 1, 2027
Cost and Financing Plan	<p>Project cost: USD 2,271.93 million</p> <p><u>Financing Plan:</u></p> <p>AIIB loan (Component A): USD 356.67 million (15.7%) Asian Development Bank (ADB) loan (Component B): USD 467.46 million (20.6%) New Development Bank (NDB) loan (Component C): USD 346.72 million (15.2%) GoTN(Components D & E): USD 1,101.08 million (48.5%)</p>
Size and Terms of AIIB Loan	USD356.67 million

	The loan will have a final maturity of 30 years, including a grace period of 9.5 years. AIIB's standard variable spread interest rate for sovereign-backed loans.
Cofinancing (Size and Terms)	ADB: Proposed for USD 467.46 million (parallel co-financing) for Component B. NDB: Proposed for USD 346.72 million (parallel co-financing) for Component C.
Environmental and Social Category	A
Risk (Low/Medium/High)	High
Conditions for Effectiveness	The appointment of a General Consultant (GC) for the Project.
Key Covenants	(i) Adequate counterpart funds to be made available for the timely and effective implementation of the Project by the GoTN, including any shortfall of funds or cost overruns. (ii) Implementation of the Project in accordance with the Environmental Impact Assessment (EIA), Social Impact Assessment (SIA), Environmental Management Plan (EMP), Resettlement Plan (RP), and Resettlement Policy Framework (RPF).
Retroactive Financing (Loan % and dates)	All expenditures up to an amount of USD 71.33 million (20% of the amount of the Loan) incurred 12 months before the expected signing date.
Policy Assurance	The Vice President, Policy and Strategy, confirms an overall assurance that AIIB is in compliance with the policies applicable to the Project.

President	Jin Liqun
Vice President	D.J. Pandian
Director General	Rajat Misra, Director General
Team Leader	Kishlaya Misra, Investment Officer
Co-Team Leader	Wenyu Gu, Senior Investment Operation Specialist
Team Members	Amanda Dompas, Young Professional Bernardita Saez, Senior Counsel Chang Tian, Project Assistant Gerardo Pio Parco, Senior Environment Specialist Jurminla, Senior Procurement Specialist Konain Khan, Technical Consultant Mengmeng He, Finance Associate Somnath Basu, Principal Environmental and Social Development Specialist Susrutha Goonasekera, Senior Social Development Specialist Yi Geng, Senior Financial Management Specialist Zhaojing Mu, Senior Operations Management Officer

2. Project Description

A. Project Overview

1. **Project Description.** The Project (Corridor 4) spanning from Lighthouse (in the east) to Poonamallee Bypass (in the west) has a length of 26.8 km, of which 16.5 km is elevated, and 10.3 km is underground, with 18 and 12 stations, respectively. The Project will be co-financed in parallel by AIIB, ADB, NDB, and with counterpart funding by GoTN. AIIB will finance the civil works of the elevated section, ADB will finance the civil works of the underground section, while NDB will finance E&M works, tunnel ventilation, traction and power supply, telecoms, etc. The GoTN will finance the general consultant, signaling, rolling stock, depot, land, R&R, state taxes, etc.

2. Chennai Metro Rail Limited (CMRL) is the Project Implementing Entity. To help improve the public transport system in Chennai, in 2007 the Government of India (GoI) and Government of Tamil Nadu (GoTN) established CMRL, a joint venture with equal equity ownership¹. CMRL is responsible for implementing, operating, and maintaining the city's metro system. CMRL has implemented the first phase of the Chennai Metro Rail², covering 54 km in two corridors.

3. The Project is being developed as part of the Chennai Metro Phase 2 Metro Rail Plan. The three corridors (Corridor 3, Corridor 4, and Corridor 5)³ of the Chennai Metro Phase 2 Metro Rail Plan is currently being developed will cover 119.6 km and are a mix of underground and elevated sections. The Project connects the eastern and western parts of Chennai, while corridors 3 and 5 enhance north-south connectivity together with Phase 1 corridors. The development of corridors 3 and 5 is currently ongoing and in parallel with the Project. The financiers involved in the Chennai Metro Phase 2 Metro Rail Plan are presented in Table 1.

Financier	Phase corridors	2 Proposed length (in km)	Total Financing arrangement
JICA	3 and 5	52	Stand-alone
ADB	3 ⁾	10.8	Stand-alone
AIIB, ADB, NDB	4	26.8	Parallel co-financing
AIIB, ADB	5 ^{**))}	30 ^{***)}	Parallel co-financing

⁾ ADB will finance the balance corridor 3 that is not financed by JICA (Balance Corridor 3).

^{**))} ADB and AIIB will finance the balance corridor 5 that are not financed by JICA (Balance Corridor 5) in parallel.

^{***)} The length includes a common section between the Project and Corridor 5 for a total of 4 km.

¹ CMRL currently has 15 Directors on the Board. Five Directors, including the Chairman, are nominated by the GoI. Five Directors, including the Managing Director and nominees of GoTN and three functional Directors. The Board also includes two Independent Directors.

² The GoI, GoTN, and the Japan International Cooperation Agency (JICA) funded the first phase that provides a direct connection between northern and southern parts of Chennai, including airport connectivity.

³ The Comprehensive Mobility Plan (CMP) for Chennai Metropolitan Area (CMA) developed in 2015 revealed CMA's present and future mobility patterns. The detailed study identified three corridors (corridors 3, 4, and 5) for the Chennai Metro Phase 2 Metro Rail Plan, considering network coverage and ease of implementation. Expanding the current metro system with environmentally friendly and socially inclusive features is imperative to alleviate CMA's public transportation constraints and enhance accessibility to prominent and rapidly growing areas within CMA.

4. **Project Objective.** To provide increased capacity and efficiency of east-west connectivity by expanding the Chennai metro system.

5. **Expected Results.** The Results Framework and Monitoring Framework in Annex 1 will be used to monitor and evaluate the achievement of the proposed Project Objective Indicators, which include:

- (i) Daily Project carrying passenger capacity (unit: number).
- (ii) Reduced journey time (unit: minute).

The proposed Project intermediate output indicators will be measured periodically throughout implementation to ensure that the Project is progressing in accordance with the implementation plan. The intermediate output indicators include indicators that demonstrate Project to be socially inclusive and environmentally sustainable. Some of these intermediate output indicators include employment during the operations stage of the Project, disaggregated by gender (of which at least 30 percent are for women) (unit: percentage); Percentage of female passengers, satisfaction with station facilities and services during operations (unit: percentage); Climate adaption/ resilience measures incorporated into Project design (unit: yes/no). Detailed information on the Intermediate output indicators is available in Annex 1.

6. **Expected Beneficiaries.** The primary beneficiaries are new metro passengers⁴ who will benefit from faster, more reliable, and better-quality transport services of metro-based travel than road-based public and private transport. This would include the female beneficiaries who would have access to a safer and convenient mode of public transportation, facilitating them with more significant opportunities to participate in education, employment, social activities, etc. The existing metro passengers will benefit from improved coverage and quality of service. The Project will also ensure universal accessibility for persons with disabilities, people traveling with small children or carrying luggage, as well as people with temporary mobility problems, pregnant women, and elderly persons, encouraging them to engage in economic activities. The secondary beneficiaries are residential and commercial establishments along the new corridor that will benefit from the improved accessibility and connectivity as well as increased economic opportunities.

B. Rationale

7. **Strategic fit for AIIB.** The proposed Project entails constructing a new corridor in the city's metro network, thereby improving the public transport system through efficient and safe connectivity, reduced journey time, increased quality and accessible mass transport, reduced carbon emission, and improved energy efficiency. As such, the proposed Project aligns with the Bank's thematic strategies:

- (i) *Transport Sector Strategy.* The Project will ensure seamless multimodal transport integration across the city of Chennai by providing integrated access to suburban rail, bus, and airport. In addition, the Project will provide increased

⁴ Further detailed in the Demand Forecast section under Economic and Financial Analysis.

urban transport capacity in the rapidly growing areas within CMA, removing traffic bottlenecks.

- (ii) *Sustainable Cities Strategy*. The Project will enhance urban mobility within CMA through high speed, reliable, safe, integrated, and comfortable mode of travel.
- (iii) *Energy Sector Strategy*. The Project is expected to result in a net reduction in greenhouse gas (GHG) emissions due to the modal shift of passengers from carbon-intensive road-based transport to a low-carbon metro system.
- (iv) *Alignment with AIIB Corporate Strategy thematic priority of Green Infrastructure and Technology-enabled Infrastructure*: The Project will enable the modal shift of passenger transport thereby leading to greenhouse gas emissions reductions. In addition, it will also incorporate climate-adaptive design/measures to increase the project's resilience to climate hazards. The Project will also adopt a technology model, namely Building Information Modeling (BIM), which would enhance the efficiency across the project life cycle of planning, implementation, and operations and maintenance.
- (v) *Alignment with United Nations Sustainable Development Goals 2030*: The Project will contribute to Goal 11 of making cities inclusive, safe, resilient, and sustainable by providing access to safe, affordable, accessible, and sustainable transport systems for all & by expanding the public transportation system.

8. **Value addition by AIIB.** AIIB has taken on a vital role in the Project preparation and coordination between CMRL and the other parallel co-financiers, in areas including technical, procurement, ES like social inclusiveness, etc. AIIB's participation has strengthened the Project by: (i) providing continued support to CMRL to enhance its capacity to understand and adhere multilateral development banks' (MDBs') procurement and ES performance requirements for a Project of such scale and complexity; (ii) proactively facilitating the discussion between CMRL and the parallel co-financiers, especially in the preparation of ES instruments; (iii) providing extensive technical assistance to CMRL in the civil tenders preparation process, for example, technical inputs related to interface and intermodal integration, BIM module guidelines, adoption of the green building features, design parameters on climate adaption, differently-abled people; and (iv) enabling a socially inclusive approach through Project by incorporating targeted interventions like pre-defined female employment during operations stage, annual survey of female passengers to ascertain the service standard and having dedicated stations being operated by all female staff.

9. In addition to the Project, the Bank is considering supporting the development of Chennai Peripheral Ring Road Sections 2 & 3 (P000336), Chennai City Partnership: Sustainable Urban Services Program (P000477), and Chennai Metro Balance Corridor 5 Project (P000368). Under the Chennai City Partnership Project, Chennai Metropolitan Urban Transportation Authority (CMUTA) operationalization is proposed. The CMUTA would serve as the unified transport authority in Chennai. Currently, there are many agencies involved in planning, operating, and managing transportation system in Chennai Metropolitan Area. The CMUTA will ensure proper coordination and streamlining of the activities among such agencies to utilize the available infrastructure facilities and resources for development. The CMUTA has been legally created by GOTN through an Act in 2011 but Act came into force in 2019 and it is not yet fully operational. AIIB, through its sectoral engagement based on the above-mentioned projects, is uniquely positioned to assist in the consolidation of the institutionalization of

integrated urban mobility and urban development in Chennai. This Project will contribute to AIIB's positioning in this dialogue, which is one of the major challenges institutionally in urban mobility.

10. **Value addition to AIIB.** The Project will: (i) strengthen the Bank's expertise in parallel co-financing transport projects where there are multiple co-financiers financing different components under the same project; (ii) further enhance the Bank's experience that will bring more opportunities to finance high-demand urban transport projects in India and the region; and (iii) help develop a close institutional partnership between AIIB and other MDBs and India's second-largest public metro rail services provider, CMRL, establishing AIIB's status as a reliable development partner.

11. **Lessons learned.** The Project has been developed based on lessons learned from the first phase of the Chennai Metro Rail and other AIIB urban rail projects. The implementation of the first phase of the Chennai Metro Rail was affected because of planning issues on land acquisition, unexpected ground conditions for the underground works, and contractors' poor performance on the underground works. Salient lessons incorporated into the proposed Project include:

- (i) ensuring early adequate planning on land acquisition and approval processes and optimization of station sizes to avoid unnecessary land acquisition.
- (ii) carrying geotechnical investigations and surveys every 25 meters to minimize unforeseen risks associated with the ground condition for underground work.
- (iii) ensuring early identification of utilities, preparation of utility shifting plan, and adequate coordination mechanism among the contractors and utility companies.
- (iv) preparing a robust tender evaluation criterion
- (v) developing and documenting close coordination mechanism among the parallel co-financiers during the Project preparation and implementation in an MoU of Cofinancing.
- (vi) incorporating design features that are friendly to the elderly, women, persons with disabilities to improve safety and the overall passenger experience.

C. Project Components

12. **Component A (AIIB financed component). Construction of 16.5 km of the elevated viaduct, including 18 elevated stations.** The component consists of a 16.5 km elevated section, from Meenakshi College ramp to Poonamallee Bypass, and includes 18 elevated stations and utilities. The elevated section will run along the median of the existing roads in most areas. The Project component would entail constructing a four km, a two-level elevated section with four elevated stations (amongst the 18 elevated stations), to accommodate the common section of the Project and Corridor 5. The station platforms will be 140 m long to accommodate six-car trains. The station design will incorporate universal accessibility, facilities for female passengers and staff, and green building features.

13. **Component B (ADB financed component):** The underground section of the Project starts from the Lighthouse and goes up to the switch over ramp after Meenakshi College station, covering a total of approximately 10.3 km. The underground section will have 12 stations. More details are in Annex 2.

14. **Component C (NDB financed component):** This component comprises financing of E&M works, tunnel ventilation system, telecoms, AFC, platform screen doors, traction, power supply. More details are in Annex 2.

15. **Components D & E (GoTN financed components):** Component D primarily comprises of general consultant, signaling, rolling stock, depot and staff quarters, permanent way, security features. And component E comprises costs associated with land, R&R, and state taxes for the entire Project. The land and R&R cost have been aggregated for the entire Project, due to the difficulty that exists in disaggregating the cost of land per component since different sections of the Project will overlap. Land acquisition is being conducted as a continuous activity for the entire Project. Land acquisition and R&R will be financed entirely by GoTN.

D. Cost and Financing Plan

Item	Cost	Financing			
		AiIB	ADB	NDB	GoTN
A. Construction of 16.5 km of the elevated viaduct, including 18 elevated stations with contingency ⁵	363.42	356.67	0.00	0.00	6.75
B. Construction of 10.3 km underground section, including 12 stations with contingency.	668.75	0.00	467.46	0.00	201.29
C. E&M works, tunnel ventilation system, telecoms, AFC, platform screen doors, traction, power supply, etc. with contingency	346.72	0.00	0.00	346.72	0.00
D. General Consultant, signaling, rolling stock, depot and staff quarters, permanent way, security features, etc. with contingency	378.11	0.00	0.00	0.00	378.11
E. Land, R&R, State taxes	514.93	0.00	0.00	0.00	514.93
Total Costs	2,271.93	356.67	467.46	346.72	1,101.08
%		15.7	20.6	15.2	48.5

16. **Parallel co-financing arrangement.** The Project is divided into several components, each of which will be separately financed by AiIB and other parallel co-financiers. The parallel co-financiers will use their own policies and procedures (along

⁵ The contingency is estimated at around 6 percent of the cost, with 70 percent financed by AiIB and 30 percent by GoTN. The two elevated civil tenders under Component A are proposed to be financed 100 percent (inclusive of tax) by AiIB. The cost associated with land and R&R, as mentioned above, has been calculated at the consolidated Project level.

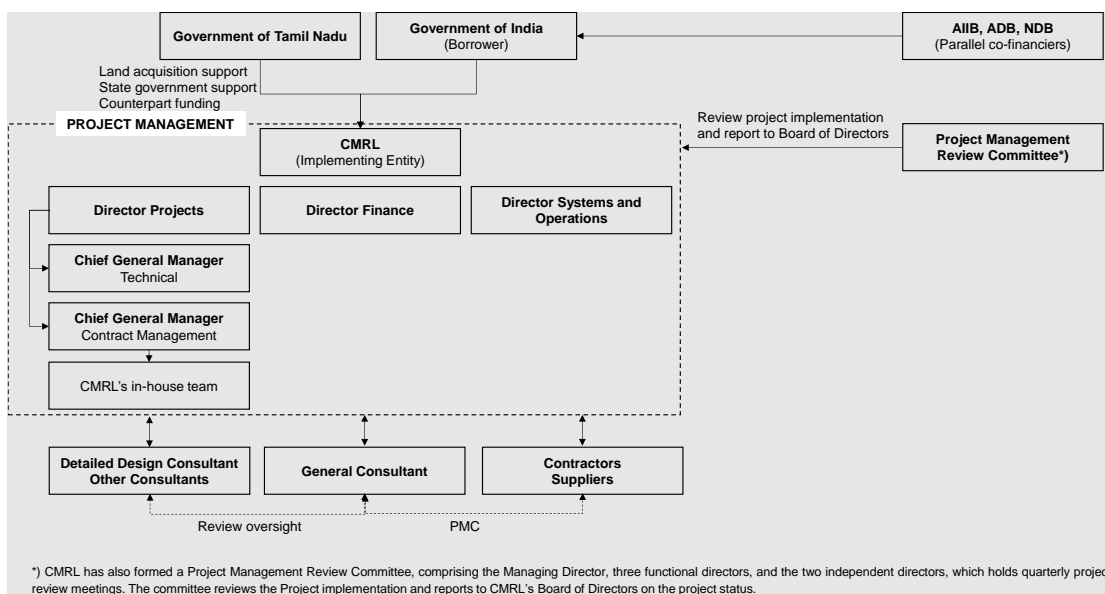
with their respective Independent Accountability Mechanism) for their respective Project components. Given the interlinked nature of Project components, the parallel co-financiers will enter an MoU to ensure collaborative cooperation and to achieve the Project objective. Owing to different project approval timelines, ADB⁶ and AIIB are proposed to first enter the MOU and NDB is to enter it at a later stage. The proposed MOU on Cofinancing would be amended to include NDB in due course.

E. Implementation Arrangements

17. **Implementation period.** CMRL plans to commission the Project (including all components) by December 2026. The elevated civil section of the Project (Component A) is scheduled to be implemented and commissioned by December 2025. The implementation schedule has been reviewed including possible delays expected due to the ongoing COVID-19 pandemic which can cause delays in the mobilization of manpower and material to the sites.

18. **Implementation Management.** CMRL will be the Project implementing entity. CMRL has a well-defined organizational management structure with clear roles and responsibilities, headed by a Managing Director. To support the Managing Director, there are Directors for Projects; Finance; and Systems and Operations, each with their respective teams. Chief Vigilance Officer and Chief Security Officer assist the Managing Director in all vigilance, security, and electrical matters, respectively. CMRL has acquired experiences from constructing and operating the first phase of the Chennai Metro Rail. To support the Project implementation and augment CMRL’s institutional capacity, consultants including the GC will be onboarded. The Detailed Design Consultant (DDC) has also been onboarded.

Figure 1. Project Implementation and Monitoring Structure



⁶ ADB financing is proposed for Chennai Metro Phase 2- Corridor 3, 4 and 5 Projects. The ADB financing for Phase 2 is proposed under Multi Tranche Financing Facility.

19. **Project Implementation.** The Director of Projects is a key management representative responsible for Project execution. The Director Projects is supported by two Chief General Managers: One of them oversees the technical aspects of the civil works while the other oversees contract management. The Chief General Manager will be the focal point for Project execution, supported by one Deputy General Manager, two Assistant General Manager, Chief Architect along with an in-house team of experts dedicated to the Project. On ES issues, Director Projects would be the key management representative responsible for environmental issues and Director Finance would be responsible for social issues.

20. The Project Management Review Committee, a sub-committee of CMRL Board of Directors, chaired by the Managing Director, CMRL holds quarterly project implementation monitoring meetings to monitor the physical and financial progress of the project. There is also a High-Powered Committee under the chairmanship of the Chief Secretary to GOTN with a composition of other members like Secretaries of the concerned departments of the state government and head of civic bodies to address and sort out issues regarding implementation, about land acquisition, diversion of utilities, shifting of structures and such other implementation-related matters. This Committee also holds regular project implementation monitoring meetings to monitor the physical and financial progress of the CMRL projects.

21. **General Consultant (GC).** CMRL will be mobilizing a GC to assist it with high-quality technical and project management assistance. The GC procurement process is underway. The Bank has reviewed the scope of work of the GC, which will cover Corridor 4 and Balance Corridor 5 projects. The GC will also provide day-to-day contract management, procurement support, construction supervision, environmental and social management activities, and quality assurance. In addition to having dedicated quality engineers, the GC will assign experts who will look after the quality and performance of the Project. For systems, the GC will prepare the basic design and the tender documents and assist CMRL in the tender evaluation. The GC will also oversee the construction, installation, testing, commissioning, and act as the engineer. Since CMRL will implement in parallel the entire second phase of the Chennai Metro Rail, the GC, along with the GC under JICA funded portion of Phase 2, will provide the critical added support to help CMRL oversee the entire Phase 2.

22. **Detailed Design Consultant (DDC).** CMRL has contracted a DDC to develop concept planning, architectural drawings, detailed structure design, and multimodal integration design as well as to prepare the Bill of Quantities (BOQ) and cost estimates. The DDC will also review the construction methodologies and the plans for utility diversion. To ensure the quality of the DDC works during the implementation, the GC will oversee the deliverables of the DDC.

23. **Procurement.** Procurement of contracts under the AIIB-financed Component will be conducted in accordance with the provisions of the Bank's Procurement Policy, January 2016, and Section II of Interim Operational Directives: Procurement Instructions for Recipients (PIR), June 2016. The procurement of works and goods will follow International Open Competitive Tender (IOCT) and National Competitive Tender (NCT)

as set out in paragraphs 10.1 and 10.4 of the Bank's PIR, respectively, using the Gol's central e-tendering platform www.eprocure.gov.in. Any contracts estimated to cost more than USD40 million for works, USD3 million for goods, and USD2 million for services will be subject to prior review.

24. **Financial Management.** The Project financial management will follow CMRL's prevailing financial management practice. The Project funds received, and expenditures incurred will be presented following the accrual basis. The unaudited Project financial statements for the entire Project will be submitted to the Bank within 45 days after the end of each quarter. The audited annual Project financial statements will be submitted to the Bank within nine months after the end of each fiscal year. The audit of the Project account will be carried out by the Comptroller and Auditor General of India. In addition to issuing an opinion on financial statements, the auditors also review the internal control system and identify any significant issues.

25. **Monitoring and Evaluation.** The overall responsibility for monitoring Project results will be with CMRL. CMRL will prepare a quarterly progress report and share it with AIIB. This report will form one of the main means of monitoring the implementation of the proposed Project. It will highlight the status of achieving agreed targets for various monitoring indicators and detail the implementation progress on every aspect of the Project. Data on Project Objective Indicators and Intermediate Results Indicators will be collected by CMRL. CMRL will also appoint a third-party consultant to ensure independent semi-annual ES monitoring of the Project during construction and annual monitoring for the first year of operation. The Bank would continuously review and monitor this independent semi-annual ES reporting report.

26. **AIIB's Implementation Support.** The Bank plans to conduct regular field visits per year to monitor progress. The Bank may conduct additional field visits as and when required, especially during the initial years. In addition, the Bank has engaged local consultants for technical, ES aspects to carry out more frequent supervision of design, construction, and ES management activities on the ground in the early stages of Project implementation.

27. The Bank and the borrower will jointly carry out a mid-term review 24 months following the implementation start date. Given the Project's complexity and financing arrangements among parallel co-financiers, a plan for joint/coordinated missions with other parallel co-financiers has been proposed as per the MoU on Cofinancing. With the travel restrictions during the COVID-19 pandemic, the AIIB team may conduct online supervision missions, and actively utilize the local consultants to physically monitor the Project's implementation progress on the ground. It is also proposed to quarterly monitor the implementation of the Project through a licensed subscription of high-resolution satellite imagery and geospatial data. Furthermore, CMRL may utilize onsite CCTV to monitor the Project implementation during the COVID-19 pandemic. CMRL is under the process to engage an agency to develop services for a centralized project implementation monitoring system.

3. Project Assessment

A. Technical

28. **Project Assessment during COVID-19.** The Project team has visited the entire Project alignment during the identification missions in 2019. Furthermore, the Project team visited Chennai for preparation missions in February and March 2020. After the state of Tamil Nadu went into lockdown in March 2020 and the travel restrictions to India were imposed, the Project team has utilized video conferencing technology with CMRL to continue with the Project assessment. The Project team has also engaged local consultants on the ground to monitor the progress of the Project preparation.

29. **Project Design.** Elevated section corridors. The alignment and the station locations have been designed to connect densely populated areas and commercial areas. The alignment design criteria follow the established global practices and standards that are well proven and widely adopted for similar metro systems in India. The elevated section will primarily run on the existing road's median to minimize land acquisitions. The elevated section will have 18 stations. The results of topographical and geotechnical investigations have been incorporated into the design of the structure.

30. **Climate change resilience.** CMA is in an earthquake-prone area, falling under Moderate Zone III as per the local seismic code, is prone to cyclone risks within 20 km of the coast, and few areas within CMA are susceptible to flooding during heavy storms⁷. The Project, being centrally located in CMA, has been designed to address these climate risks.

31. The Project design adopts climate change resilience features to contribute towards the reduction of vulnerability to the detrimental impacts of these climate-related events. These features including the durability (complete and adequate drainage; sufficient concrete cover and limiting crack width), wind load (longitudinal & transverse), seismic load (with adequate importance factor and zone factor considering CMA is under seismic zone III), temperature load (overall temperature and differential temperature effects are considered), and rainfall in Chennai, to also be aligned with Indian Railway standards. Stipulation of Bureau of Indian Standards engineering codes shall be met while designing the structures to consider micro zonation of Chennai in terms of seismic risks. The drainage design considers the rainfall intensity and the catchment area to mitigate the detrimental effects of water accumulating during heavy rain. The provisions for Solar panels on the roof of elevated stations are considered in the designs. The indicative cost of climate adaptive measures including the estimated cost for drainage & rain harvesting pits of elevated stations is estimated at INR 36 million (USD0.47 million).

32. **Adoption of green building features.** The design and construction of the Project will have environmentally friendly features to help reduce its carbon footprint. The stations

⁷ Key climate related risk as per Second Master Plan for Chennai Metropolitan Area 2026, Chennai Metropolitan Development Authority, Government of Tamil Nadu.

are envisaged to qualify for the platinum rating⁸ from the Indian Green Building Council (IGBC) and will have features such as water and energy conservation measures, dedicated spaces for bicycles and green vehicles, and signage to raise environmental awareness. Furthermore, CMRL plans to install solar panels on the roofs of the elevated stations and use natural lighting for illumination by having an open configuration at the platform level. The lighting fixtures used will make use of LED-based technology to reduce energy consumption.

33. **Station design for safety, accessibility, and gender sensitivity.** The stations will include gender and universal accessibility features, which will benefit women and persons with disabilities. To illustrate, the stations will have full coverage by closed-circuit television cameras, all public areas will have adequate lighting to ensure no dark spots, and designated areas for ladies coaches will be provided at platforms. The Project plans to have at least two stations that are entirely operated by female staff to encourage female workforce participation. CMRL has a dedicated general helpline number for addressing customer concerns. Access ramps for persons with disabilities, elevators, escalators, tactile paths for visually challenged passengers, seating areas with handrails, dedicated space for wheelchairs inside the train will be provided for universal accessibility. There will be signage of international standards to help passengers locate the ticketing areas, platforms, and station exits. Platform screen doors will be installed to separate the platform from the train to prevent accidents and further enhance passenger safety.

34. **Interface Management.** As the Project involves several parallel co-financiers financing different components, the GC's role in interface management will be critical to ensure seamless integration of the various Project components and integration with the first and second phases of the Chennai Metro Rail corridors. The GC will have positions of experts in system integration and interface management. To assist in the interface management, the Project will utilize a Building Information Modelling (BIM) technology, which entails a digital and graphic representation in a model. In India, there have been proven cases of adoption of BIM to improve efficiency in rail and metro projects.

35. The key benefit of adopting BIM technology is during the design and construction phase by enabling easier integration of the design of various Project components and identifying any potential conflicts leading to early identification and obviate any time and cost overrun scenario. 3D BIM model adoption is expected to have benefit across the full project cycle:

- (i) Planning phase: systematic feasibility study, reduced unnecessary rework, increased accuracy of the early cost estimate, more clear design requirement, and construction specification.

⁸ IGBC Green Mass Rapid Transit System (MRTS) is a tool to enable new rail based MRTS to apply green concepts during design & construction, to further reduce environmental impacts that are measurable. IGBC MRTS rating was launched to encourage green concepts in the design, construction & operation of rail based MRTS addressing green features of site selection and planning, water efficiency, energy efficiency, material conservation, indoor environment and comfort and innovation in design and construction. The DDC and the Contractors will ensure the incorporation of IGBC features and certifications, supported by the GC.

- (ii) Design phase: enhanced collaboration even from a remote location, an automatic reflection of a design change to reduce errors, reduced time and money spent on post-correction.
- (iii) Construction phase: enhanced collaboration between different vendors, reduced time and cost, leaner construction, and less onsite waste.
- (iv) Operation and maintenance phase: increased accuracy of materials maintenance and asset drawing to reduce maintenance downtime and asset duration.

36. A key factor to maximize the effect of BIM is to ensure the involvement of both decision-makers and participants in the BIM process. To ensure participation and to support CMRL in utilizing the technology, a BIM consultant has already been mobilized. The BIM consultant would work in close coordination with CMRL, GC, DDC, and the Contractors under the overall control of CMRL.

37. **Intermodal Integration.** The Project will have seven interchange stations with other metro corridors. The Project will also enable access to Chennai Airport through the Nandanam station that will be an interchange station between the Project and Phase 1 corridor. Multimodal integration will be provided through walkways, elevators, and convenient placement of entry/exit structures, depending on the location, to ensure that commuters get seamless transit options to other metro corridors, bus terminals, and other transport modes. The Project team has reviewed these integrations and will monitor their implementation during the construction. They are covered in detail in Annex 2. Automated Fare Collection (AFC) for fare collection and payment mode integration with other transit and non-transit modes are proposed. To help plan the travel and enhance the experience of using public transport, passengers can use the CMRL mobile app to check the train arrival time on a real-time basis, route information, fares for the desired journey, and the feeder services available.

38. **Operational sustainability.** CMRL is currently the third largest operational rail network in India, hence have a proven track record of governance and management of O&M activities. The O&M activities will be primarily outsourced and CMRL has comprehensive training programs in place for the outsourced staff to ensure satisfactory operations. The key O&M activities proposed for outsourcing include services like housekeeping, ticketing, train operation, security, and maintenance of systems, and rolling stock. The core control of O&M planning, execution, and monitoring will be with CMRL. Key performance indicators are implemented on performance and linked with payments to the outsourced domestic private contractors. All outsourced contractors for O&M activity are currently selected by CMRL through open tenders by following standard competitive bidding process according to local legislation. The Board of Directors of CMRL has also established an O&M Committee⁹ to regularly review the O&M activities, develop targets, and recommend initiatives to improve the operational performance and results. To improve the operating revenue, CMRL plans to adopt measures to increase the non-farebox revenue from advertising, kiosk and shop rental, semi-naming rights licensing, and others.

⁹ The O&M Committee comprises of the Managing Director, the three functional directors, a nominee of the Gol from Railway Board, the Commissioner of the Greater Chennai Corporation, and a nominee of the Gol, and the Director Projects & Planning from Bangalore Metro.

B. Economic and Financial Analysis

39. **Demand Forecast.** Ridership forecast for the Project is driven by the commercial and residential growth along the east to west areas of Chennai. Population and employment data are the underlying assumptions in estimating trip production, the trip attraction for peak hours, and ridership forecasting. The forecast is also derived from the traffic survey and willingness to pay survey undertaken. The annual population growth in CMA is estimated at 2.5 percent from 2011 to 2045, while employment growth is estimated at 1.1 percent for the same period. The daily ridership for the Project is estimated to grow at an average rate of 4.3 percent per year until 2037, before stabilizing to 1.87 percent until 2047, and 1.20 percent until 2057. It is assumed that the rise in ridership declines as other modes of public transport would also be available. The estimated traffic forecast for the Project is summarized in Table 3.

Year	Max PHPDT*	Daily boarding	Average Trip Length (km)
2026	11,707	508,881	10.98
2035	18,944	775,491	11.24
2045	23,816	933,285	11.50
2055	29,940	1,051,525	11.77

* Peak Hour Peak Direction Traffic

40. The estimated PHPDT and daily ridership figures have also been projected based on the proposed developments as envisaged in the Master Plan of Chennai and the realization of other planned transport infrastructure projects. Under the base case scenario (using a conservative approach) for the economic and financial analysis of the Project, the ridership for the first four years of operations was assumed to be 25 percent of the forecast level.

41. **Economic Analysis.** Economic analysis was carried out to assess the economic viability of the Project and Phase 2 of Chennai Metro. In the analysis, the economic prices of the capital and annual O&M costs are derived from the financial cost estimates. Standard Conversion Factors (SCF) are applied to convert the financial costs into economic prices. The Project is expected to generate both tangible and non-tangible benefits. Reductions in travel time of passengers, Vehicle Operating costs (VOC), and fuel consumption are the estimated significant social benefits. Additional benefits include reductions in accidents, pollution, and road maintenance costs. Under the base case scenario with a discount rate of 9 percent, the Project yields an economic net present value (ENPV) of USD 953 million and an economic internal rate of return (EIRR) of 12.48 percent. The investment for the Project is thus economically viable. Similarly, the assessment done for Phase 2 of Chennai Metro has ascertained that Phase 2 operations are also economically viable. The sensitivity analysis was carried out by varying the economic cost and benefits. Further details of the economic analysis are presented in Annex 3.

42. **Financial Analysis.** The capital and O&M costs have been estimated based on the DPR, the first phase of the Chennai Metro Rail and its extension, as well as other metro projects in India. O&M cost includes staff wages, energy, and repair & maintenance

costs. Non-fare revenue generally varies from 20 to 35 percent of the fare revenue for similar projects in India. The non-fare revenue has been cautiously assumed as 20 percent of the farebox revenue. Based on the assumptions mentioned above, the FIRR for the Project is 3.02 percent. Further details of the financial analysis are presented in Annex 3.

43. **Financial Sustainability.** If any shortfall occurs during the operations stage, the GoTN will provide Shadow Cash Support (SCS) to CMRL by funding the SCS account or bridging a cash gap. The GoTN will also provide support to CMRL for servicing any shortfalls in senior debt repayment. Two sub-divisions are available for the implementation of SCS: (i) reimbursement of cash loss and (ii) step-in cash support. The first one is to cover the operating loss. CMRL submits its annual audited accounts annually and requests reimbursements of the annual operating cash loss. For step-in cash support, CMRL prepares the required support request three months in advance with the updated financial status and submits it to GoTN every quarter.

C. Fiduciary and Governance

44. **Procurement.** Procurement of contracts under the AIIB-financed Component will be conducted in accordance with the provisions of the Bank's Procurement Policy. A project delivery strategy has been prepared by CMRL and agreed with the Bank. The project delivery strategy outlines details of procurement arrangements including the tendering and contracting strategies, capacity assessment, assessment of operational factors affecting procurement, supply market assessment, procurement risk and proposed mitigation measures, prior review thresholds for Component A.

45. CMRL has proposed a procurement approach that entails the use of IOCT and NCT for contracts based on the cost estimate, risk, and complexity. Both methods will follow a single-stage, two-envelop system without prequalification for the civil contracts. As proposed in PDS, CMRL will use Bank's Standard Tender Document for large works and FIDIC 2010 Contract Conditions for these two civil work packages.

46. As per the current procurement plan, there is only two large elevated IOCT civil works package. To meet Gol's readiness criteria, CMRL has already initiated tendering of these two packages using Gol's central e-tendering platform (www.eprocure.gov.in) after seeking necessary clearance from the Bank. The tender evaluation process (both technical and financial) has been completed and CMRL is in the process of contract negotiation for both the packages with the identified contractors.

47. All types of procurement under Component A of this Project have been conducted using Gol's e-tendering platform that will enhance transparency and efficiency in terms of the procurement process. This system has been assessed and found to be a reliable system in terms of security. The system is also being used by other MDBs. Based on the outcome of the overall assessment of the procurement process, the procurement risk for the Project has been rated as Medium.

48. **Financial management.** The financial management arrangements for the Project have been assessed and are satisfactory and meet the requirements of

Operational Policy on Financing (March 20, 2020). An assessment has concluded that adequate financial management arrangements will be in place for the Project to provide reasonable assurance that the proceeds of the financing will be used for the purposes for which they are granted.

49. CMRL has successfully implemented the first phase of the Chennai Metro Rail project financed by JICA and accumulated experiences in fiduciary requirements and processing procedures. Key financial staffs are experienced and competent. The financial management system of budgeting, accounting, financial reporting, funds flow, internal control including internal audit, and external audit, has been assessed as acceptable. Issues identified in the previous audit report of FY 2019 have been addressed or rectified.

50. Accounting and reporting. CMRL has implemented Ind-AS¹⁰ since April 1, 2016, with a comprehensive Accounting Procedure Manual (APM), a codified document to standardize its accounting and financial reporting work. CMRL uses an open-source accounting ERP called Odoo (version 12) to keep financial records. Each project is captured by an “analytical account” (project code). Accrual basis accounting will be adopted to record all transactions following internal review and approval procedures. Project financial statements reflecting all sources and usage of all project funds could be generated from the system and reporting format will be harmonized among all financiers.

51. Counterpart Funding. Since the Project is currently being developed as a state sector project the counterpart funding would be through the State Government of Tamil Nadu. The government of Tamil Nadu has given all requisite approvals in this regard.

52. Internal Control. Enough internal control and reviewing procedures will be in place in contract management, and an internal audit will properly function before making the final payment. All bank payments follow strict authorization levels, and the daily bank reconciliation system is in place. For fixed asset management, separate software is maintained to keep updated asset details, including location and date of capitalization. Internal audit reports are discussed in the quarterly Audit Committee meetings and appropriate actions are taken to address issues.

53. Fund flow arrangements. The Finance Department, GoTN will make an annual budget allocation in its Budget Estimate (BE) based on the request from CMRL. This request of CMRL would be based on the estimated AIIB annual loan disbursement requirement, to come through from GoTN, as a form of Pass-Through Assistance. The GoTN would facilitate both its counterpart funding requirement and the Pass-Through Assistance in its annual budgetary allocation for CMRL. Using this budgetary fund allocation from GoTN, the payments would be made by CMRL to contractors/consultants and then the claim for the same would be submitted by CMRL to the Controller of Aid Accounts and Audit (CAAA) of the Ministry of Finance, GoI. CAAA will approve all WAs and submit applications to the Bank. Designated account to be opened and managed by CAAA would be available as needed to address the funding

¹⁰ Ind-AS refers to the accounting standards as specified in the Annexure to the Companies (Indian Accounting Standards) Rules, 2015.

needs during implementation. The Pass-Through Assistance at the central level¹¹ or state level has been an established government process for metro projects in India and will support the timely release of funds for the Project.

54. **Disbursements.** The disbursements from the Bank will be made in accordance with the Loan Agreement between the Bank and the borrower and the disbursement letter, the disbursement manual, and other relevant policies and guidelines. The disbursement arrangement would be a reimbursement-based method. The detailed disbursement arrangements will be set out in the Disbursement Letter.

55. **Governance and Anti-corruption.** AIIB is committed to preventing fraud and corruption in the projects it finances. AIIB places the highest priority on ensuring that the projects that AIIB finances are implemented in compliance with AIIB's Policy on Prohibited Practices (2016). Implementation will be monitored regularly by AIIB staff. The Bank reserves the right to investigate, directly or indirectly through its agents, any alleged corrupt, fraudulent, collusive, coercive, or obstructive practices, and misuse of resources and theft or coercive practices relating to the Project will require the borrower to take necessary measures to mitigate the risk of such practices and address any issues in a timely manner, as appropriate. AIIB will monitor the work related to tender document preparation and tender/proposal evaluation under the Bank financing.

D. Environmental and Social

56. **Applicable Environmental and Social Policy.** The Project will be governed by different ES policies, depending on which parallel co-financier is financing the Project component. The Bank's Environmental and Social Policy (ESP), including the relevant Environmental and Social Standards (ESSs), and Environmental and Social Exclusion List will apply to the AIIB-financed Component. The Bank will rely on each parallel co-financiers' determination as to whether such parallel co-financiers' policy has been complied with for its respective components. In the case of the GoTN-financed components, each parallel co-financier's policy will govern the aspects of these components that are relevant to the component the respective parallel co-financier will finance; thus, for example, resettlement under Component E that is required for Component A will be governed by the ESP and ESS2.

57. **Categorization and Instruments.** The AIIB-financed Component of the Project has been screened and reviewed in accordance with the ESP and ESSs, and the Project has been assigned Category A. ESS 1 (Environmental and Social Assessment and Management) and ESS 2 (Involuntary Resettlement) are applicable to the Project. The environmental and social (ES) documentation has been prepared following adoption of a harmonized approach among AIIB, ADB, NDB and the GoTN. An Environmental Impact Assessment (EIA) accompanied with an Environmental Management Plan (EMP) and a Social Impact Assessment (SIA)/Resettlement Plan (RP) accompanied with a Resettlement Policy Framework (RPF) have been prepared by CMRL (taking into consideration all project components financed by the parallel co-financiers) and jointly reviewed by all co-financiers to comprehensively assess all components of the Project.

¹¹ For Central Sector Project same mechanism is adopted with Ministry of Housing and Urban Affairs, Government of India

These ES instruments have been prepared in adherence to the respective ES policies of all the co-financers.

58. **Environment.** The Project is expected to generate environmental and socio-economic benefits in terms of decreasing the vehicle exhaust emission from traffic congestion and serving the growing travel demand. The alignment and depot area were carefully selected to avoid the environmentally/ecologically sensitive areas. However, under Component B, supported by ADB, the section from Lighthouse to Foreshore Road section with a length of 1.3 km is unavoidably located in Coastal Regulatory Zone (CRZ) IA and CRZ II, for which CRZ clearance shall be obtained and the given conditions in the clearance shall be adhered to. No construction will be commenced within CRZ until the CRZ clearance is obtained for the concerned underground section. 536 trees will be felled along the corridor. The compensatory replantation plan of planting twelve saplings for each tree to be felled has been adopted for use in the Project.

59. Other negative environmental impacts of the Project will be temporary and reversible during the construction phase, including air pollution, noise and vibration, and disposal of construction wastes that have been addressed in the EMP. The EMP also includes mitigation plans and provisions related to occupational and community health and safety, labor camp and construction site management, and traffic and public utility management, etc. The EMP accompanied by an Environmental Monitoring Plan with a detailed EMP budget of USD 3.19 million, describes the mitigation measures for the identified impacts, the roles, and responsibilities for EMP implementation, and institutional arrangements for monitoring, reporting, and capacity building.

60. **Climate Change.** The Project will support climate mitigation by encouraging a modal shift from road-based urban transport to a sustainable low-carbon and high-capacity metro system with a net reduction of GHG emissions. As stated in para 30 and para 31, the Project will also take into consideration the climate change effects of an anticipated continuous increase in ambient temperature, the intensity of cyclones and storm surge, heavy precipitation events, and sea-level rise in the future.

61. Several climate adaptation and mitigation measures to be integrated into the Project design include: (i) installation of floodgates at stations with flooding risks; (ii) improving adaptability to seasonal thermal variations in the stations through the use of large open spaces for unrestricted air movement, cross-ventilation and ensuring that enclosed areas are well ventilated; (iii) designing for better adaptability to rising sea level/high tide/heavy flooding through the use of higher plinth levels and check valves for sewer lines in flood-prone areas and the use of resilient materials that can get wet and then dry out with minimal damage; (iv) using solar panels of 10 MW for Phase 2 on station buildings and roofs to reduce the extensive use of grid-generated electricity supplied to the station and depot for its operation and maintenance; and (iv) through better station roof design, providing for rainwater harvesting by channeling rainwater through gutters and pipes to either harvesting pits in the ground or to recharge groundwater. As a result, based on the joint MDB methodology for climate finance tracking, 100% of AIIB financing (USD 356.67 million) will be considered as climate finance, among which US\$356.2 for climate mitigation and US\$0.47 million for climate adaptation.

62. **Social Aspects.** Key social risks associated with the Project are related to land acquisition and physical and/or economic displacements. The Project will require the acquisition of 24.5 ha of land, out of which 8.0 ha of land is under private ownership. A total of 429 structures will be affected out of which 85 are fully affected and 344 are partially affected structures. There are 1,031 Project Affected Families (PAFs) comprising of 4,755 Project Affected Persons (PAPs). 297 PAFs will be physically affected, 733 PAFs will be economically displaced and a further PAF will be both physically and economically affected. The final figures may see some revision due to site constraints during construction that may necessitate slight alterations in design. The SIA/RP including the RPF, and the Entitlement Matrix has been prepared. An approximate budget and implementation schedule for Resettlement and Rehabilitation have been worked out in compliance with the ESP.

63. **Gender Aspects.** The Project will increase the ease and safety of travel of women commuters. It is expected that female labor force participation will increase because of this Project. More broadly, the Project will contribute to poverty reduction by way of improving public services for the population, particularly for the poor, women, and other vulnerable groups, creating more and better jobs by promoting economic activity and improving social development outcomes. The potential impact of project activities on women in the community has been assessed in the SIA. A Gender Action Plan was prepared accordingly. In consultation with relevant stakeholders, including CMRL and community members, measures have been identified to prevent potential negative impacts caused by the influx of migrant workers in the community and the risk of gender-based violence and included in the management plans.

64. **Occupational Health and Safety, Labor and Employment Conditions.** The EMP and the Safety, Health, and Environment Manual of CMRL, formulated in accordance with all applicable legislation and Indian statutory requirements as well as international standards and guidelines, has been part of tender documents for contractors to implement. CMRL will also ensure that civil works contractors comply with all applicable labor laws and regulations and adopt and enforce codes of conduct for all workers. The contractors shall prepare a COVID-19 Response and Management Plan in line with the World Health Organization and GoI guidelines, taking into consideration of the COVID-19 health and safety practices.

65. **Stakeholder Engagement, Consultation, and Information Disclosure.** Consultations have been held during the preparation of the EIA, SIA/RP, and RPF. This will continue during Project implementation, in accordance with national and state guidelines on restrictions imposed due to the COVID-19 pandemic. The English versions of the EIA, SIA/RP, and RPF, and the Tamil versions of the Executive Summaries of

the EIA, SIA/RP, and RPF have been posted on CMRL's¹² and Bank's websites¹³ and made available in hard copies in the Project area in October 2020.

66. **Project Grievance Redress Mechanism.** A multi-tier Project-level Grievance Redress Mechanism (GRM) has been constituted for the Project in line with the requirements of the ESP. Communities and individuals who believe that they are adversely affected by the Project will be able to submit complaints to the project-level GRM for their resolution. In addition to the above GRM for addressing complaints from the local community, a GRM will be established at the contractor level for worker grievances.

67. **Bank's Project-Affected People's Mechanism.** Bank's Project-affected People's Mechanism (PPM) will apply to the AIIB-financed Component. It has been established by the Bank to provide an opportunity for an independent and impartial review of submissions from PAPs who believe they have been or are likely to be adversely affected by the Bank's failure to implement its ESP, in situations when their concerns cannot be addressed satisfactorily through the project-level GRM or the AIIB's Management processes. Information about the PPM is available at: <https://www.aiib.org/en/policies-strategies/operational-policies/policy-on-the-project-affected-mechanism.html>. Each parallel co-financier's Independent Accountability Mechanism (IAM) or Compliance Department will handle complaints relating to ES issues that may arise under the Components of the Project that such parallel co-financier is financing. With respect to the GoTN's Components, each parallel co-financier's IAM will govern those elements that are related to the Component financed by such parallel co-financier. In accordance with AIIB's Policy on the PPM, submissions to the PPM under Project components other than the AIIB financed Component A of the Project (and relevant elements of Components D and E) will not be eligible for consideration by the PPM.

68. **Monitoring and Supervision Arrangements.** CMRL will be responsible for overall coordination, supervision, and monitoring of the Project's ES aspects. CMRL has established an ES team to look after ES aspects associated with the design, implementation, and monitoring of the Project. CMRL will engage an external monitor to verify the semi-annually internal ES monitoring reports prepared by CMRL with assistance from GC. AIIB will conduct ES supervision mission at least semi-annually, together with other parallel co-financiers where feasible. With the travel restrictions during the COVID-19 pandemic, the AIIB team may conduct online supervision missions

12 <https://chennaietrorail.org/wp-content/uploads/2020/10/EIA-Report-CMRL-Phase-II-Corridor-4.pdf>
https://chennaietrorail.org/wp-content/uploads/2020/10/EIA_Executive_Summary_Corridor_4_Tamil.pdf
<https://chennaietrorail.org/wp-content/uploads/2018/07/Approved-Social-Impact-Assessment-Resettlement-Plan-Corridor-4.pdf>
<https://chennaietrorail.org/wp-content/uploads/2018/07/SIA-Executive-summary-tamil-version-scanned-copy.pdf>
<https://chennaietrorail.org/wp-content/uploads/2018/07/Approved-AIIB-Resettlement-Planning-Frame.pdf>
<https://chennaietrorail.org/wp-content/uploads/2018/07/Resettlement-Planning-Framework-Tamil-Version.pdf>

13 <https://www.aiib.org/en/projects/details/2019/proposed/India-Chennai-Metro-Rail-Phase-2-Project-Corridor-4.html>

instead of field visits, and actively utilize the local ES consultants on the ground to monitor the implementation progress of the Project. As proposed in the MoU, all parallel co-financiers will handle ES aspects of the project collaboratively.

E. Risks and Mitigation Measures

Table 4: Summary of Risks and Mitigating Measures

Risk Description	Assessment (H/M/L)	Mitigation Measures
<p>COVID-19 pandemic. Potential impact on project preparation and execution of the COVID-19 pandemic.</p>	High	<p>CMRL is utilizing online conferences and other information technology tools for timely completion of the Project preparation task and minimizing delays. CMRL is also using technology to conduct pre-bid meetings with tender participants.</p> <p>Furthermore, CMRL is strictly following the standard operating procedure issued by the government for operations activities during the pandemic and has assigned the General Manager Operations to be responsible for compliance monitoring. COVID-19 related response measures have also been included in Project EMP/EMOP.</p>
<p>Land acquisition. Delays in land acquisition and approval processes.</p>	High	<p>The total land requirement for the Project is 24.5 ha, out of which 8.0 ha of land is under private ownership. Currently, approximately 57 percent of the land required for the Project has been acquired by CMRL and an independent verification of land acquisition and resettlement will be undertaken to ensure compliance with the project's resettlement framework. The Project team would continue monitoring the progress.</p>
<p>Environmental and social. Non-compliance with ES plans. CRZ clearance needs to be obtained before the construction commencement of the concerned underground section</p>	High	<p>EMP and EMoP as reviewed by the Bank have been incorporated in the civil contracts.</p> <p>The GC provides ES support through the facilitation of the implementation of ES plans. The GC would prepare a quarterly ES monitoring report for the project. The GC would also have key personnel such as the Chief Environment, Health, and Safety Expert to support and monitor the Project's ES performance. Third-party monitoring and evaluation will be conducted semi-annually to ensure effective implementation of ES plans and produce monitoring reports during Project implementation.</p> <p>Under Component B (financed by ADB), State Coastal Zone Management Authority and State</p>

Risk Description	Assessment (H/M/L)	Mitigation Measures
		Environment Impact Assessment Authority have been consulted closely for document preparation of the CRZ clearance.
<p>Technical Complexities. Technical Complexities in interface management within the Project and with the other metro corridors.</p>	High	<p>CMRL's interface management capacity will be enhanced with the GC's support. The GC will have positions of experts in system integration and interface management. The Project will also utilize BIM technology to aid with the interface management and ensure seamless integration of various Project components. The BIM consultant has been mobilized. AIIB and the other parallel co-financiers have proposed to enter an MOU on Cofinancing to keep other parallel co-financiers informed on contractual events, any project amendments, changes, and extensions.</p>
<p>Implementation. Delay in work due to lack of coordination between contractors and utility companies.</p>	Medium	Management of identifying and shifting utilities will be undertaken at multiple levels. The GC will monitor the coordination between the contractors and the utility companies to ensure timely execution of utilities identification and shifting.
<p>Implementation. Delays due to unforeseen geotechnical conditions.</p>	Medium	Geotechnical investigations and surveys were carried out every 25 m along the corridor.
<p>Procurement. Contractual Management issues arising post-award of civil tenders</p>	Medium	CMRL has accumulated experience in contract management from the first phase of the Chennai Metro Rail and the civil tender documents have specified a clear dispute resolution mechanism.
<p>Financial Management. Appropriate and timely counterpart fund</p>	Low	The counterpart funds currently are to be contributed by the GoTN. GoTN will ensure budget allocations are enough and accordingly timely funds to CMRL will be made available, including cost overrun scenarios. Designated account to be opened and managed by CAAA would be available as needed to address the funding needs during implementation.
<p>Financial Sustainability.</p>	Low	GoTN has approved to maintain the metro's financial viability and provide financial support to

Risk Description	Assessment (H/M/L)	Mitigation Measures
Financial gaps during the operation stage.		the Project to ensure financial sustainability for the Project during the operation stage.

Annex 1: Results Monitoring Framework

Project Objective:	The objective of the Project is to provide increased capacity and efficiency of east-west connectivity by expanding the Chennai metro system.												
Indicator Name	Unit of measure	Base-line Data Year	Cumulative Target Values							End Target (2027)	Frequency	Responsibility	
			2021	2022	2023	2024	2025	2026	2027				
Project Objective Indicators:													
1. Daily Project carrying passenger capacity	Number	0 (2020)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	127,220	127,220 ¹⁴	Annually	CMRL
2. Reduced journey time	Minutes	120 ¹⁵ (2020)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	49	49	Annually	CMRL
Intermediate Results Indicators:													
1. Elevated viaducts stations constructed – civil works	Percentage	0 (2020)	15	40	65	90	100	100	100	100	100	Annually	CMRL
2. Indian Green Building Council (IGBC) Platinum	Number	0 (2020)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	18	18	Annually	CMRL

¹⁴ This assumes the ridership as per the base case economic analysis.

¹⁵ This is based on the journey time in the bus from beginning to end of the proposed line in 2020.

Project Objective:	The objective of the Project is to provide increased capacity and efficiency of east-west connectivity by expanding the Chennai metro system.											
Indicator Name	Unit of measure	Base-line Data Year	Cumulative Target Values							End Target (2027)	Frequency	Responsibility
			2021	2022	2023	2024	2025	2026	2027			
rating for elevated stations												
3. Number of Project stations designated to be fully operated by women	Number	0 (2020)	N/A	N/A	N/A	N/A	N/A	N/A	2	2	Annually	CMRL
4. Employment during operations stage of the Project, disaggregated by gender (of which at least 30 percent are for women)	Percentage	0 (2020)	N/A	N/A	N/A	N/A	N/A	N/A	30	30	Annually	CMRL
5. Percentage of female passengers, satisfied with station facilities	Percentage	0 (2020)	N/A	N/A	N/A	N/A	N/A	N/A	75	75	Annually	CMRL

Project Objective:	The objective of the Project is to provide increased capacity and efficiency of east-west connectivity by expanding the Chennai metro system.											
Indicator Name	Unit of measure	Base-line Data Year	Cumulative Target Values							End Target (2027)	Frequency	Responsibility
			2021	2022	2023	2024	2025	2026	2027			
and services during operations												
6. Universal accessibility features incorporated into Project design	Yes/No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Annually	CMRL
7. Climate adaptation/resilience measures incorporated into Project design	Yes/No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Annually	CMRL

Annex 2: Detailed Project Description

1. The second phase of the Chennai Metro Rail has three corridors and is 119.6 km long. The Project provides east-west connectivity, while corridors 3 and 5 enhance north-south connectivity together with Phase 1 corridors. All three corridors will comprise elevated and underground sections, as detailed in Table A2.1.

Table A2.1. Phase 2 Corridors Route Length

Corridor	Total length (km)	Elevated (km)	Underground (km)
Corridor 3	45.8	19.1	26.7
Corridor 4	26.8	16.5	10.3
Corridor 5	47	41.2	5.8

2. All three corridors have interchanges with each other. Corridors 3 and 5 have two interchange stations at Madhavaram Milk Colony in the north and Okkiyam Thoraipakkam in the south. Corridor 4 has four stations in common with corridor 5 that will act as interchange stations and will be connected to corridor 3 at Thirumayilai station. These three corridors also have interchange stations with Corridors 1 and 2 of Phase 1. Corridor 1 provides a connection to Chennai Airport. The Chennai metro Phase 1 and Phase 2 network is presented in Figure A2.1.

Figure A2.1. Chennai Metro Network: Phase 1 and 2



Source: CMRL

B. Detailed Description of Project Components

3. The Project involves AIIB Components and the remaining components to be financed by other co-financiers in parallel. AIIB will finance the civil works of the elevated section, ADB will finance the civil works of the underground section, while NDB will finance E&M works, tunnel ventilation, traction and power supply, telecoms, etc. The GoTN will finance the signaling, rolling stock, depot, etc.

4. The progress of corridors 3 and 5 is ongoing. JICA has approved the financing for the development of corridors 3 and 5 with a total length of 52 km. ADB is proposed to finance the other components for corridor 3 that are not financed by JICA (Balance Corridor 3). ADB and AIIB are proposed to finance the other components for corridor 5 that are not financed by JICA (Balance Corridor 5).

5. **Component A. Construction of 16.5 km of the elevated viaduct, including 18 elevated stations.** This component consists of the elevated section from Meenakshi College (excluding) to Poonamallee station. The alignment will predominantly run along the median of existing roads. There will be a switch-over ramp between the elevated and underground sections between Meenakshi College and Powerhouse station (the first elevated station). The scope of this Project component begins after the switch over ramp at chainage 10.027 km of the Project alignment. The tenders are item rates based on the design and Bill of Quantities already finalized by the DDC. This form of tenders will mitigate the risks arising out of uncertainties of working in an old organically grown city like Chennai. Any unforeseen situation (unchartered utilities, for example) that necessitates alterations in the design will just result in different quantities of items that will be taken care of item rates in the contract, thus mitigating the risk.

6. **Structures.** A topographical survey was carried out in detail using modern surveying instruments. The geotechnical investigations determined the required strength characteristics of the underlying soil/rock strata to design the foundation of the proposed structure. Bore holes at every 25 meters were drilled along the proposed Project alignment. Also, since the proposed site is in seismic Zone III of India, suitable seismic measures are being adopted in the design of the structures.

7. The sub-structure will be constructed mainly using pile foundations with pier caps at the top of the columns. The construction will use a single line of piers with portals at locations where a single pier is not possible or cannot take the load. The superstructure is being planned as segmental using U-girders and I-girders. Incorporating a lesson learned from the first phase of the Chennai Metro Rail and other metro projects, the U-girders are being planned to be launched using launching girders instead of road cranes. The pier arms are being designed as precast elements that require only launching time at the site, avoiding in-situ works on the road using staging. All these measures will result in less disruption to traffic, thus speeding up the work.

8. **Elevated stations.** This Project component includes 18 elevated stations. The interstation distance varies from 676 m to 1,418 m, with an average of 917 m. Most of the stations will be constructed using the cantilever method. A typically elevated station consists of three levels: entry/exit structure at ground level on either side of the road, a concourse on the middle level, and platforms at the top. Passenger facilities, operational, and commercial areas are provided at the concourse level. In addition to the staircases, elevators and escalators will be installed to connect the different levels. Platforms will be at a height of 12-15 m and the concourse floor at about 8 m above the road, with a minimum of 5.5 m of vertical clearance under the concourse for

road traffic. The stations will include gender-friendly and socially inclusive features to provide universal accessibility, which will benefit women and persons with disabilities.

9. **Interchanges with other metro corridors and other transport modes.** The second phase of the Chennai Metro Rail corridors will have interconnectivity with other existing and proposed metro corridors, airport, bus terminals, MRTS, and rail terminals. It is envisaged that feeder services will be made available to enhance the overall transport system's seamless integration, thereby incentivizing people to take public transport. Corridor 4 will have seven interchange stations comprising one station with Corridor 1, Corridor 2, and Corridor 3 each, and four stations with Corridor 5. This Project component A will cover five interchange stations of these, with four having an additional platform level for the interchanging line at the height of around 19 m, and at Vadapalani station, which will be separate from the Phase 1 Vadapalani station but connected by a 120 m long elevated walkway.

10. Apart from the interchanges with other CMRL corridors, the Project team has gone into the details of all possible integrations with major hubs of other modes of transport and reviewed them with CMRL. These features will also be monitored during the construction of the Project. These hubs include MRTS and suburban stations at Lighthouse, Thirumayilai, and Kodambakkam; and bus terminals at Iyyappalthangal Bus Depot and Poonamallee Bus Depot. The integration will be affected using walkways and strategic placement of entry/exit structures and will not only result in more flexibility for passengers but also contribute to an increase in ridership.

11. **Common alignment with Corridor 5.** The Project meets Corridor 5 between Avichi School and Alwarthiru Nagar, and both corridors will share a common alignment for about 4 km covering four stations, finishing at Alapakkam station. The line of these two corridors will be laid on the same piers but at different levels, with Corridor 5's line running over that of the Project. A crossover arrangement will exist between Valasaravakkam and Karabakkam to transfer trains from one line to another during non-revenue hours. Since the Right of Way was limited in the central part of Chennai city and it was considered techno-economically less feasible in having duplicate stations in close vicinity, it was decided by CMRL to have common stations for C-4 and C-5 with the same structure but at different levels.

C. Other Metro Components not funded by the Bank.

12. **Component B: Underground section (to be financed by ADB and GoTN).** The underground section of the Project starts from Lighthouse and goes up to the switch-over ramp after Meenakshi College station, covering a total of approximately 10.3 km. The underground section will have 12 stations. The rail levels of the corridor, excluding the switch-over ramp, will vary from -23.93 m to -8.11 m. The steepest gradient will be at the switchover ramp at 3.5 percent. The underground alignment will be constructed using tunnel boring machines, the cut and cover method, and the New Austrian Tunneling Method. Underground stations will be constructed using the cut and cover method, or in case of limited right of way, the New Austrian Tunneling Method.

13. **Component C: Traction and Power supply (to be financed by NDB).** The Project will run on 25 kV AC overhead traction and will be fully integrated with the power supply system running on Phase 1. The 25 kV AC Overhead Catenary System allows for energy efficiency through lower losses and higher regeneration. Two receiving sub-stations at Avichi School and Panagal Park stations will supply power for traction and auxiliary services from the Tamil Nadu Transmission Corporation Limited grid sub-stations through transmission lines or cable feeders. The Traction Substations at these locations will convert the incoming supply to 25 kV and feed it to the overhead line for traction. The auxiliary supply at the stations will cover all non-traction needs and there will be an Auxiliary Substation at each station for this purpose. The entire power supply and traction network will be controlled through a supervisory control and data acquisition (SCADA) system. Platform Screen Doors (PSD) interlocked with the signaling system will be installed at the stations for the safety of passengers.

14. Other rail systems planned for the Project will be based on the latest proven technology and will include telecommunications based on digital transmission systems using optical fibers, mobile radio communications, public address systems at stations. Other systems, financed by NDB, include an automatic fare collection (AFC) system for automated ticketing, environment control, and tunnel ventilation systems for the underground portion of the Project.

15. **Component D: Track (to be financed by GoTN).** To reduce maintenance and replacement, the Project will use Head Hardened rails of grade 1080 with 60 kg UIC section for main lines. For other lines and the depot, 60 kg rails of grade 880 (without Head Hardening) are proposed. The rails will conform to the Indian Railway standards with a cant of 1 in 20. The rolling stock will be compatible with such specifications. The gauge will be a standard gauge (1435 mm). The track structure will be ballast-less for the mainline and conventional ballasted for the depot. The mainline will have 1 in 9 types of turnouts, and the depot will have 1 in 7 types. The design speed will be 80 km per hour, and the track will be able to take an axle load of up to 16 tons.

16. **Signaling and Train Control (to be financed by GoTN).** The signaling and train control system being planned on the corridor is CBTC based on IEEE 1474.1 standard with a fourth level grade of automation (GoA 4) which is unattended train operation (UTO). The rolling stock will also be suitable for UTO. The data from the wayside to Operation Control Centre will be taken through an optical fiber network laid all along the alignment with full redundancy. CBTC will be overlaid on a conventional axle counter-based signaling system having signals for guidance and backup.

17. **Depots (to be financed by GoTN).** The maintenance facilities for the Project will be near Poonamallee Bypass and will have the capacity for 31 trains of 6 cars for maintenance and repairs of the operational rolling stock. The depot facilities will include stabling lines, scheduled inspection lines, a workshop for overhaul and unscheduled major repairs, wheel re-profiling, and train cleaning, etc. besides maintenance facilities for track, traction, signaling, telecommunications, and other rail systems. Automation with state-of-the-art machinery will be used to ensure quality and reliability.

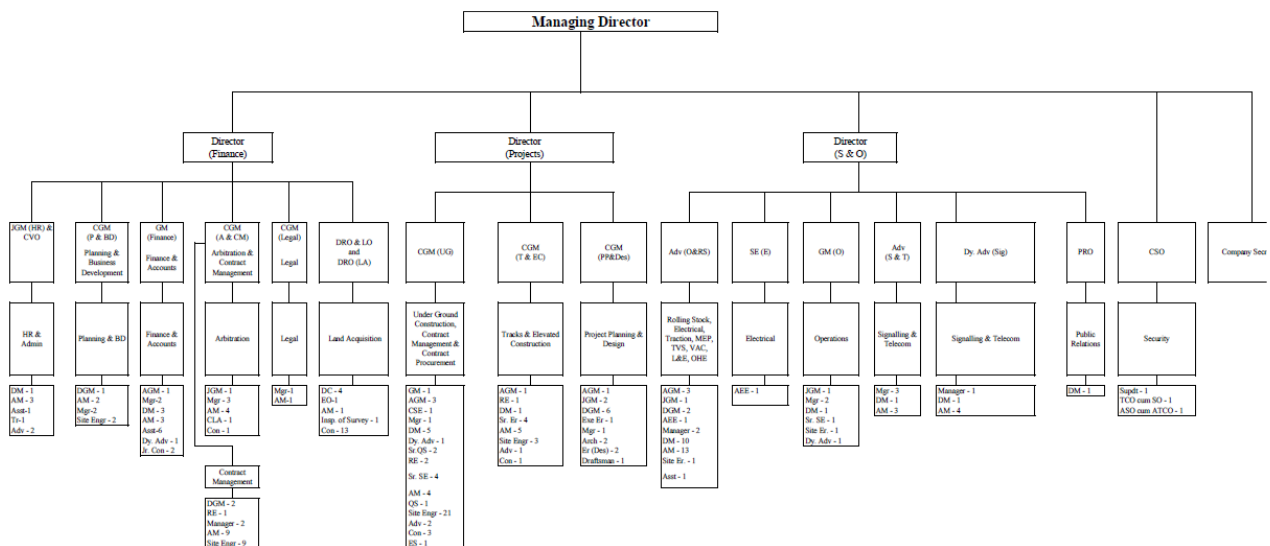
18. **Rolling stock (to be financed by GoTN).** The rolling stock specifications include 2.9 m-wide coaches with 3- and 6-car configurations, like that of the first phase of the Chennai Metro Rail. The rolling stock will also be equipped with an on-board CBTC signaling system, automated doors, computerized control, and facilities for PWDs and female passengers. All these systems will be designed by the contractors or original manufacturers and reviewed and supervised by the GC.

19. **General Consultant (to be financed by GoTN):** The component consists of the financing of the GC, which will provide overall support to CMRL on project management, construction supervision, and quality control. Since CMRL will implement in parallel the entire second phase of the Chennai Metro Rail, the GC, along with the GC under JICA funded portion of Phase 2, will provide the critical added support to help CMRL oversee the entire Phase 2. As such, the GC would serve a critical role in the interface and coordination management. GC will include experts in various fields identified for the Project and will provide comprehensive support to CMRL in the areas including contracts, track works, rolling stock, elevated and underground sections, signaling, power supply, traction, system integration, health, and safety, etc.

D. Implementation arrangement

20. CMRL will be the project implementing entity, with the Project execution being led by the Director Projects. The detailed organization structure is presented in Figure A2.2. As of April 2021, CMRL had 545 employees, with 270 employees working on the project development and 275 O&M employees working on the existing projects. Further, CMRL has 1887 outsourced employees working across various departments.

Figure A2.2. CMRL Organization Structure



Source: CMRL

21. **Implementation Schedule.** CMRL plans to commission the Project (including all components) by December 2026. The elevated civil section of the Project (Component A) is scheduled to be implemented and commissioned by December 2025. The implementation schedule has been reviewed including possible delays expected due to the ongoing COVID-19 pandemic which can cause delays in the mobilization of manpower and material to the sites. Further, the GC will prepare and regularly update a detailed implementation program in consideration of technical challenges, internal and external coordination, which will be regularly reviewed by AIIB during Project implementation.

E. Operation & Maintenance

22. **Operations and Maintenance activities:** As part of Phase 2 operations, CMRL has proposed that most of the O&M activities would be outsourced to private players. The core control of O&M will be with CMRL, and the supporting maintenance and other ancillary activities would be outsourced. To ensure cost efficiencies, the following O&M activities shall be outsourced to private players, namely, (i) Housekeeping services of Stations, Administration office & Depot; (ii) Ticketing services at Stations, parking and Crowd control team; (iii) Train Operation services; (iv) Security services; (v) Traffic Regulator of Mainline traffics at Operation Control center & Depot train movement regulator at Depot control office; (vi) Maintenance of signaling, telecom, Traction & Power systems, MEP, Lift & escalators, Automatic Fare collection systems, etc. and Rolling stock-preventive maintenance. To ensure quality control, key performance indicators are proposed on performance and shall be linked with payments to the private contractors.

23. **Operation Plan.** The metro will have a maximum design speed of 80 km per hour and a scheduled speed of 32 km per hour. Revenue operations will be from 5:00 AM to 12:00 AM. No services are proposed between 12:00 AM and 5:00 AM, which are reserved for maintenance of infrastructure and rolling stock. Key features of the estimated train operation plan are given in Table A2.2. With eight passengers per square meter, the carrying capacity will be optimal and more than the PHPDT. The selection of trains is based on the projected ridership. In the first decade, three-car trains are planned, and six-cars trains will be introduced in the subsequent decades as the demand increases.

Table A2.2. The Project's Estimated Peak Headway and Capacity

Items	2026	2035	2045	2055
Cars per train	3	3&6	3&6	6
Headway in sec.	277	277	257	240
Trains/hour	13	13	14	15
3 car trains	13	6	3	0
6 car trains	0	7	11	15

Capacity (@6pax/m ²)	9,958	15,628	19,634	23,640
Capacity (@8pax/m ²)	12,675	19,878	24,969	30,060
PHPDT	11,707	18,944	23,816	29,940

24. Transit-Oriented Development. The Project envisages the maximization of non-fare revenue by transit-oriented development guided by the Transit Oriented Development policy of the Government of India. The policy focuses on the creation of high-density mixed land use development in the influence area of the stations and advocates pedestrian access to various facilities like shopping, entertainment, and work. Non-fare revenue will include revenue through shops and kiosks at the stations, station naming rights, and advertisements at stations and in trains, amongst other things. It is envisaged that the increase in ridership will result in an increase in non-fare box revenue while such facilities at stations will attract more ridership.

25. Last-mile connectivity. The Project will have last-mile connectivity through non-motorized transport options as well as feeder bus services. Feeder services considering different catchment areas are proposed. Other services being planned include shared taxis, rented bicycles, and electric autorickshaws. It is envisaged that the feeder services in the Project can be booked through the CMRL mobile app. The mobile app enables the payment for such services using the same travel card for the metro travel, creating an integrated ticketing system across the metro and the feeder services.

Annex 3: Economic and Financial Analysis

A. Introduction

1. The economic and financial analysis was undertaken to assess the economic and financial viability of the second phase of the Chennai Metro Rail as well as the Project. For the economic evaluation, the applied methodology is cost-benefit analysis. The cost-benefit analysis entails the comparison of the incremental economic benefits and costs from the Project to the transportation infrastructure in CMA. A social discount rate of 9 percent has been observed recently for large public transportation projects with long-term benefits in India. Under the base case, the Project is economically viable with an EIRR of 12.48 percent, and an ENPV of USD 953 million using a 9 percent discount rate. The analysis does not quantify all possible positive externalities from the Project, mainly as it is a section of a more extensive transport network with long-term benefits and possible spillover effects. Further, financial analysis of the Project and a financial assessment of CMRL were undertaken.

B. Economic Analysis

2. **Cost-benefit analysis and key assumptions.** The economic analysis is carried out for the Project and the entire second phase of the Chennai Metro Rail. The three corridors developed for the second phase of the Chennai Metro Rail will help alleviate the transportation constraints. Based on the Comprehensive Mobility Plan for CMA, the three corridors are selected and prioritized based on the passengers per hour per direction (PPHPD) forecast.¹⁶

3. All costs and benefits are estimated at constant 2021 prices with an average exchange rate of INR75.01/USD. The economic analysis is conducted over 36 years starting from 2021 until 2056.

4. **Project cost.** Economic prices of the capital and annual O&M costs are derived from the financial cost estimates with adjustments to allow for transfer payments, taxes, subsidies, and corrections for any market distortions. Standard Conversion Factors (SCF) are applied to convert the financial costs into economic prices¹⁷. The economic costs of the Project comprise of the following:

- (i) **Capital cost.** As per CMRL's latest estimates, the capital cost for the Project is approximately USD2,271.93 million at 2021 prices. Taxes are deducted from the capital cost, and the estimated market value of the land acquired for the project is added¹⁸ to arrive at the completion cost of USD1,926.58 million at 2021 prices (see

¹⁶ Comprehensive Mobility Plan for Chennai Metropolitan Area, Urban Mass Transit Company Limited, February 2018.

¹⁷ The SCF are in accordance with the Appraisal Guidelines for Metro Rail Project Proposals issued in September 2017 by the Ministry of Housing and Urban Affairs, Government of India (capital cost SCF: 0.83; operating cost SCF: 0.87; time cost savings SCF: 1.00; vehicle operating cost savings SCF: 0.90; emission cost savings: 1.00; accident reduction saving: 0.90; infrastructure maintenance cost savings: 0.87).

¹⁸ It is estimated that in Tamil Nadu, the land's market value is adopted in the analysis to capture the opportunity cost, which is 40 percent of the land acquisition costs.

Table A3.1). The distribution of capital cost across the respective six-year construction period of the entire Project has been estimated as 7.5%, 19%, 23.5%, 23.5%, 19%, and 7.5% as per CMRL's latest estimates.

Table A3.1: Economic Cost of the Project (USD million)

	Corridor 4 (the Project)
(1) Civil construction	999.01
(2) Land acquisition (40% of the total cost)	159.48
(3) Other works and systems	757.99
(4) Resettlement and rehabilitation	10.1
Total (1+2+3+4)	1,926.58
Economic cost with SCF of 0.83	1,599.06

Additional investments in new coaches and receiving substations are planned to meet the projected increase in traffic. CMRL will purchase additional coaches after 10 years and 20 years of operations, and new receiving substations after 10 years of operations. Further, based on CMRL's estimates, electrical works & rolling stock, signaling, and telecom works would require replacement after 20 years. It is assumed in the analysis that the Project components have a useful life of 30 years, as such, the Project's salvage value at the end of the analysis period only includes the residual values of the Project's replacement components¹⁹.

- (ii) **O&M costs.** O&M cost includes staff wages, energy, and repair & maintenance costs. O&M cost under various categories has been estimated as per the costs incurred in the first phase of the Chennai Metro Rail and other metro projects in India.

5. **Project benefits.** The Project will generate tangible and non-tangible savings. Significant social benefits will result from a reduction in fuel consumption, vehicle operating cost, and travel time of passengers. Additional benefits include reductions in accidents, pollution, and road maintenance costs.

- (i) **Savings in Vehicle Operating Costs (VOC).** VOC is mainly comprised of costs for vehicle maintenance, fuel, and depreciation. Without the metro, passengers would have traveled using buses, two-wheelers, three-wheelers, and cars as alternate modes of transport in CMA. Savings in VOC are estimated for different transport modes. Shares of alternate transport modes are assumed to be 44.20 percent, 36.60 percent, 10.30 percent, and 8.90 percent for buses, two-wheelers, three-wheelers, and cars, respectively²⁰. Average occupancy as per the travel demand modeling in the DPR is 67 for buses, 1.20 for two-wheelers, 2 for three-wheelers, and 2 for cars. VOC

¹⁹ Based on CMRL's estimated useful life of property, plant, and equipment, as described in CMRL's Annual Report 2019, page 179.

²⁰ Comprehensive Mobility Plan for Chennai Metropolitan Area, Urban Mass Transit Company Limited, February 2018.

per km is estimated to be INR61.71 (USD0.82) for buses, INR5.01 (USD0.07) for two-wheelers, INR8.27 (USD0.11) for three-wheelers, and INR14.87 (USD0.20) for cars²¹. In the analysis, the ATL on the metro for the Project is taken at 11.37 km, and factors are applied to calculate the ATL of respective vehicles on road²². The number of operational days in a year is assumed at 340 days.

- (ii) **Savings in Value of Travel Time of Passengers (VOT).** The metro system will be faster than the alternate road-based transport modes. A shift to the metro would reduce congestion on the road, generating a considerable time saving for those passengers traveling on road²³. As per the estimates in the DPR, the average speed of the metro is 32 km/hour, whereas the average speed of alternate modes of transport without the metro is taken as 13 km/hour for buses, 18 km/hour for two-wheelers, 16 km/hour for three-wheelers, and 18 km/hour for cars in the analysis.

The VOT is estimated based on Tamil Nadu's per capita income, which is INR218,599 at the current prices²⁴. With a labor participation rate of 45 percent²⁵ and 23 working days a month, income per capita for working time is INR220 (USD2.93) per hour. The non-working time is valued at 40 percent of the income per capita of the working passengers. The figures are further adjusted to account for different transport modes following the estimates in the DPR²⁶. Based on these calculations, VOTs for working time for different transport modes at 2021 prices are INR83.61 (USD1.11) per hour for buses, INR128.70 (USD1.72) per hour for two-wheelers, INR101.09 (USD1.35) per hour for three-wheelers, and INR264 (USD3.52) per hour for cars²⁷. The VOT is assumed to grow in line with India's wage growth in real terms, at an average of 5.5 percent from 2008 to 2017²⁸.

- (iii) **Savings in Emission Costs.** Factors such as fewer vehicles due to diversion to an efficient metro system and decongestion of the existing road network would lead to a reduction in GHG emissions. Unlike the existing transport system, which runs on a combination of petrol, diesel, and compressed natural gas, the metro will be operated

²¹ VOC is estimated based on the Manual on Economic Evaluation of Highway Projects in India (Indian Road Congress Special Publication 030) published in 2009 for economic cost of operations of vehicles on two lane roads, aligned with most of the road networks in CMA. VOC rates are brought to 2021 prices levels from 2009, the year used in the manual, using an inflation rate of 7.65 percent per year (average annual consumer price inflation from 2009-2018 in India as per World Bank data).

²² The ATL factor is calculated as the ATL for respective vehicles divided by the ATL of the metro.

²³ The analysis adopted a conservative approach and has not considered the value of VOC and VOT savings for passengers who continue to use road-based transport with lesser congestion and higher speed.

²⁴ Handbook of Statistics on Indian Economy, Reserve Bank of India-2019-20.

²⁵ Women and Men in India, Ministry of Statistics and Programme Implementation, Government of India 2014

²⁶ A value of 120% of the income per capita is applied to calculate the VOT for cars. The VOT for other transport modes are estimated based on the preparation of Metro Rail Master Plan of Chennai Metropolitan Area by CDM Smith in 2015. The figures as 31.67% for buses, 48.75% for two-wheelers, and 38.29% for three-wheelers, of the VOT for cars.

²⁸ International Labor Organization (ILO) Global Wage report 2019

entirely through an electric system, thereby further enhancing the GHG emission reduction potential. In the analysis, carbon emissions from the metro as well as alternate modes of transport of diverted passengers have been calculated with Defra emission factors²⁹. Bharat Stage norms³⁰ are in accordance with the European emission norms. Emission factors of two-wheelers, three-wheelers, and cars are approximately 132.84 gCO₂e per km, 232.20 gCO₂e per km, and 207.97 gCO₂e per km, respectively. Emission factors of buses and metro are 120.42 gCO₂e per km and 35.08 gCO₂e per km, respectively.³¹ An uplift factor of 1.15 is applied to the emission factors from diverted traffic to account for real-world driving effects. The social price of carbon emission is estimated based on the values by the High-Level Commission on Carbon Prices.³² A range of USD41-82 per ton of CO₂e is estimated in 2021, and the midpoint value of USD61 per ton of CO₂e is used in the analysis. Beyond 2030, the prices are calculated by assuming an increase of 2.25 percent per year³³. It is estimated in the analysis that the modal shift from road-based transport to metro would generate GHG emissions reduction of 10.3 million tons over the entire project life cycle.

- (iv) **Savings on Road Maintenance Costs.** The metro is expected to contribute to a modal shift from road-based travel and would lead to savings in infrastructure costs, such as road maintenance costs. Annual expenditure on roads is assumed at INR0.5 (USD0.007) per vehicle km based on the industry standard in India.
- (v) **Savings in Accident Costs.** The modal shift to the metro system is expected to reduce accidents on the metro corridor. Further, a reduction in accidents will lead to savings from avoided damage to vehicles. There were 7,580 road accidents reported in Chennai in 2018.³⁴ The cost of accidents is estimated based on the study undertaken Ministry of Housing and Urban Affairs, Gol, and adjusted to the 2021 prices.³⁵ The cost of an accident is estimated to be INR25.69 (USD0.34) per vehicle at 2021 prices. The economic benefits of avoided fatalities and accidents are not quantified due to the complexity of valuing human life.

²⁹ Greenhouse Gas Reporting – Conversion Factors 2019, Department for Environment Food & Rural Affairs, UK

³⁰ Bharat stage emission standards are the emission standards instituted by the Gol to normalize the productivity of air pollutants from internal combustion engine equipment. The standards and the timeline for implementation are set by the Central Pollution Control Board under the Ministry of Environment & Forests and Climate Change, Government of India. Bharat Stage norms are based on the European regulations.

³¹ The emission factors for average motorbikes and average cars are considered for two-wheelers and cars, whereas emission factors for average local bus and light rail and tram are taken for buses and metro. The emission factor for three-wheelers is calculated by multiplying the emission factor for cars by a factor of 1.12. The factor is derived based on estimates of emissions for cars and three-wheelers in the DPR.

³² N. Stern and J. E. Stiglitz (2017). *Report of the High-Level Commission on Carbon Prices*. World Bank. www.carbonpricingleadership.org/report-of-the-highlevel-commission-on-carbon-prices. This report of the High-Level Commission on Carbon Prices, a group of economists convened by the Carbon Pricing Leadership Coalition, was supported by staff of the International Bank for Reconstruction and Development/ International Development Association (The World Bank)

³³ See footnote 33 and 34.

³⁴ Road Accidents in India, Ministry of Road Transport and Highways, Transport Research Wing, Government of India https://morth.nic.in/sites/default/files/Road_Accidednts.pdf

³⁵ Appraisal Guidelines for Metro Rail Project Proposals issued in September 2017 by the Ministry of Housing and Urban Affairs, Government of India.

6. **Non-quantitative benefits.** In addition to the quantifiable benefits considered in the economic analysis, the expected non-quantitative benefits of the Project are the following:

- (i) Economic stimulation in the micro-region of the infrastructure.
- (ii) Reduced road fatalities and injuries.
- (iii) Increased business opportunities and job creation.
- (iv) Reduced air pollution (in addition to GHG emissions) and noise.
- (v) Social empowerment of women and PWDs in the region through safe and easy access to public transport.
- (vi) Increased access to educational institutions for children in the Project area.
- (vii) Facilitation of better planning and up-grading of the Project area.

7. **Results of the Economic Cost-Benefit Analysis.** Under the base case scenario, the Project yields an EIRR of 12.48 percent and ENPV of USD953 million with a discount rate of 9 percent. The EIRR and ENPV for the entire second phase of the Chennai Metro Rail project is 12.86 percent and USD3,727.41 million, respectively. Savings in VOT account for 72.8 percent of the economic benefits. A major portion of the remaining benefits comes from savings in VOC 20.0 percent. The EIRR and ENPV results are presented in Table A.3.2.

Table A3.2: Economic Evaluation Base Case Scenario

The Second Phase of the Chennai Metro Rail Corridor	EIRR (%) Base Case	ENPV at 9% (USD million)
Corridor 4 (the Project)	12.48%	953
Corridors 3, 4, and 5 (entire second Phase)	12.86%	3,727.41

Sensitivity analysis. The sensitivity analysis of the EIRR was carried out on a relatively higher scale of 20 percent with respect to changes in the economic costs and benefits. The analysis suggests that the economic viability of the investment would be robust to withstand joint variations in the economic cost and reduction in traffic. The economic evaluation and sensitivity analysis are shown in Table A3.3 and the detailed cash flows of the EIRR calculation are shown in Table A3.4.

Table A3.3: Economic Evaluation and Sensitivity Analysis for the Project

Parameter	EIRR (%)	ENPV at 9% (USD million)	ENPV at 8% (USD million)	ENPV at 6% (USD million)
Base case scenario	12.48%	953	1,405.3	2,722.1
Increase in economic cost by 20%	11.16%	657.2	1,098.1	2,387.5
Reduction in estimated traffic by 20%	10.88%	466.6	817.1	1,843.1
Increase in economic cost by 20% and reduction in traffic by 20%	9.62%	170.9	509.9	1,508.5

Parameter	EIRR (%)	ENPV at 9% (USD million)	ENPV at 8% (USD million)	ENPV at 6% (USD million)
Increase in economic cost by 20% and reduction in traffic by 20% and without savings on road maintenance cost and savings on accident costs	9.53%	146.9	481.4	1,467.8

Table A3.4: The Project EIRR Calculation for the Project in USD million (Base Case Scenario)

Year	Capital Cost	O&M Cost	Total Costs	Savings in VOC	Savings in VOT	Savings in Emission	Savings on Infrastructure maintenance	Savings due to accident reduction	Total Savings	Net Cash Flow	Discounted Cash Flow
2021	119.9	-	119.9	-	-	-	-	-	-	(119.9)	(119.9)
2022	303.8	-	303.8	-	-	-	-	-	-	(303.8)	(278.7)
2023	375.8	-	375.8	-	-	-	-	-	-	(375.8)	(316.3)
2024	375.8	-	375.8	-	-	-	-	-	-	(375.8)	(290.2)
2025	303.8	-	303.8	-	-	-	-	-	-	(303.8)	(215.2)
2026	119.9	-	119.9	-	-	-	-	-	-	(119.9)	(77.9)
2027	-	17.5	17.5	18.8	26.1	4.0	1.0	0.0	50.0	32.4	19.3
2028	-	17.5	17.5	20.4	28.8	4.3	1.0	0.0	54.5	37.0	20.2
2029	-	17.5	17.5	21.3	31.6	4.6	1.1	0.0	58.6	41.0	20.6
2030	-	20.7	20.7	22.2	34.8	4.9	1.1	0.0	63.0	42.3	19.5
2031	-	20.7	20.7	92.6	153.3	20.8	4.6	0.1	271.4	250.7	105.9
2032	-	24.0	24.0	96.6	168.6	22.2	4.8	0.1	292.4	268.4	104.0
2033	-	24.0	24.0	100.8	185.6	23.7	5.0	0.1	315.2	291.2	103.5
2034	-	24.0	24.0	105.1	204.2	25.3	5.2	0.1	339.9	316.0	103.1
2035	-	24.0	24.0	109.7	224.7	27.0	5.5	0.1	366.9	342.9	102.6
2036	-	24.0	24.0	114.4	247.3	28.8	5.7	0.1	396.2	372.2	102.2
2037	73.9	25.1	99.0	119.3	272.1	30.7	5.9	0.1	428.1	329.1	82.9
2038	-	25.1	25.1	121.5	292.4	31.9	6.1	0.1	452.0	426.9	98.6
2039	-	25.1	25.1	123.8	314.3	33.3	6.2	0.1	477.6	452.5	95.9
2040	-	25.1	25.1	126.1	337.7	34.7	6.3	0.1	504.9	479.8	93.3
2041	-	25.1	25.1	128.5	363.0	36.1	6.4	0.1	534.1	508.9	90.8
2042	-	25.1	25.1	130.9	390.1	37.6	6.5	0.1	565.2	540.1	88.4
2043	-	25.1	25.1	133.3	419.2	39.2	6.6	0.1	598.5	573.4	86.1
2044	-	25.1	25.1	135.8	450.6	40.8	6.8	0.1	634.1	608.9	83.9
2045	-	25.1	25.1	138.3	484.2	42.5	6.9	0.1	672.1	647.0	81.8
2046	-	25.1	25.1	140.9	520.4	44.3	7.0	0.1	712.8	687.7	79.7
2047	174.2	26.1	200.3	143.6	559.3	46.1	7.2	0.1	756.3	556.0	59.2
2048	-	26.1	26.1	145.3	597.2	47.7	7.2	0.1	797.5	771.4	75.3
2049	-	26.1	26.1	147.0	637.6	49.4	7.3	0.1	841.4	815.3	73.0
2050	-	26.1	26.1	148.8	680.7	51.1	7.4	0.1	888.1	862.0	70.8
2051	-	26.1	26.1	150.6	726.8	52.9	7.5	0.1	937.8	911.7	68.7
2052	-	26.1	26.1	152.4	775.9	54.7	7.6	0.1	990.7	964.6	66.7
2053	-	26.1	26.1	154.2	828.4	56.6	7.7	0.1	1,047.1	1,021.0	64.8
2054	-	26.1	26.1	156.1	884.5	58.6	7.8	0.1	1,107.0	1,080.9	62.9
2055	-	26.1	26.1	157.9	944.3	60.6	7.9	0.1	1,170.9	1,144.8	61.1
2056	(140.7)	26.1	(114.6)	159.8	1,008.2	62.7	8.0	0.1	1,238.9	1,353.5	66.3
	1,706.4	726.2	2,432.6	3,516.1	12,791.9	1,077.0	175.3	2.9	17,563.2	15,130.6	953.0
				20.0%	72.8%	6.1%	1.0%	0.0%			
										EIRR (%)	12.48%
										Economic NPV	953.0

C. Financial Analysis

8. **Capital Costs.** The capital costs have been estimated as per the DPR and are based on various contracts recently awarded by the first phase of the Chennai Metro Rail and its extension, as well as other metro projects in India. The assumed methodology for the capital cost estimation is aligned with the current industry practice.

9. **O&M cost.** O&M cost includes staff wages, energy, and repair & maintenance costs. O&M cost under various categories has been estimated as per the costs incurred in the first phase of the Chennai Metro Rail. The staff cost on a route length basis from other operating metro projects in India has been adopted for the Project. Energy costs were estimated based on the prevailing unit energy cost in CMA and the Project's forecasted energy consumption. The energy costs were escalated in the eleventh and twenty-first year of operations to reflect increased energy consumption from additional metro operations. The maintenance cost is estimated based on the projected phase one O&M cost after adjusting for the route length of the Project and assuming the same cost for 2021. As mentioned in DPR, owing to the gradual ramp-up of operations, the full O&M cost will be incurred by the Project from the sixth year of operations.

10. **Farebox revenue.** The farebox revenue is the main revenue source for the Project, and the fare system is distance-based. The estimated fares have been conservatively assumed for the projection period which starts in 2027. An annual escalation of 7.5 percent to the nominal fare structure is assumed for the Project³⁶. In the analysis, the farebox revenue has been deflated at the inflation rate to the base year. Like other metro projects in India, the Project's fare will subsequently be fixed by the Fare Fixation Committee.

Table A3.5: Fare Structure for the Project

Trip Length (km)	Fare (INR)	Trip Length (km)	Fare (INR)
0-2	10.00	12-15	50.00
2-4	20.00	15-18	50.00
4-6	30.00	18-21	60.00
6-9	40.00	21-24	60.00
9-12	40.00	>24	70.00

11. **Non-fare revenue.** Non-fare revenue generally varies from 20 to 35 percent of the fare revenue for similar projects in India. The non-fare revenue has been cautiously assumed at 20 percent of the farebox revenue. The non-fare box revenue resources include advertising revenue, automatic teller machine fee, automated vending machine, and income from property

³⁶ Delhi Metro, the oldest metro in operations in India has experienced four fare fixations by the Fare Fixation Committees since the inception of its operations in 2001. As per the Metro Railways (Operations and Maintenance) Act 2002, the Fare Fixation committee shall be constituted by Government of India from time to time and shall comprise of three members. The Act states that the Chairperson would be an ex/sitting judge of High court and the Government of India, and the state government will nominate one member each.

development, as per CMRL’s non-fare strategy and operation in the first phase. CMRL has been able to generate non-fare revenue which was around 38.6 percent of the fare revenue in 2020³⁷.

12. **The outcome of the financial analysis.** Based on the assumptions mentioned above, calculations for FIRR were carried out. The evaluation results show that the FIRR is 3.02 percent for the Project³⁸. The weighted average cost of capital (as calculated) has been used as a discount factor to calculate the NPV. The salvage value is adopted using a similar approach to that of the EIRR calculation. Given farebox revenue being the main benefit stream from the investment, the fare escalation and ridership projections will thus have a crucial impact on the FIRR. The analysis is summarized in Table A3.6.

Table A3.6: FIRR Calculation in US\$ million (Base Case Scenario)

Year	Capital Cost excl. IDC	Manpower Cost	Energy Cost	Repair & Maintenance Cost	Total O&M Cost	Fare Box Revenue	Non-Fare Box Revenue	Total Revenue	EBITDA	After-tax EBITDA	Net Cash Flow
2021	(344.14)	-	-	-	-	-	-	-	-	-	(344.14)
2022	(558.40)	-	-	-	-	-	-	-	-	-	(558.40)
2023	(437.83)	-	-	-	-	-	-	-	-	-	(437.83)
2024	(437.83)	-	-	-	-	-	-	-	-	-	(437.83)
2025	(353.99)	-	-	-	-	-	-	-	-	-	(353.99)
2026	(139.73)	-	-	-	-	-	-	-	-	-	(139.73)
2027	-	9.12	7.39	3.65	20.16	17.93	3.59	21.51	1.36	1.00	1.00
2028	-	9.12	7.39	3.65	20.16	19.33	3.87	23.20	3.04	2.25	2.25
2029	-	9.12	7.39	3.65	20.16	20.85	4.17	25.02	4.86	3.60	3.60
2030	-	9.12	7.39	7.30	23.80	22.48	4.50	26.98	3.17	2.35	2.35
2031	-	9.12	7.39	7.30	23.80	96.99	19.40	116.39	92.59	68.51	68.51
2032	-	9.12	7.39	11.05	27.56	104.61	20.92	125.54	97.98	72.50	72.50
2033	-	9.12	7.39	11.05	27.56	112.85	22.57	135.41	107.85	79.81	79.81
2034	-	9.12	7.39	11.05	27.56	121.73	24.35	146.08	118.52	87.70	87.70
2035	-	9.12	7.39	11.05	27.56	131.32	26.26	157.59	130.03	96.22	96.22
2036	-	9.12	7.39	11.05	27.56	141.68	28.34	170.02	142.46	105.42	105.42
2037	(88.98)	9.12	8.70	11.05	28.87	152.87	30.57	183.44	154.57	114.38	25.40
2038	-	9.12	8.70	11.05	28.87	161.09	32.22	193.30	164.43	121.68	121.68
2039	-	9.12	8.70	11.05	28.87	169.76	33.95	203.71	174.84	129.38	129.38
2040	-	9.12	8.70	11.05	28.87	178.91	35.78	214.69	185.82	137.51	137.51
2041	-	9.12	8.70	11.05	28.87	188.57	37.71	226.28	197.41	146.08	146.08
2042	-	9.12	8.70	11.05	28.87	198.76	39.75	238.52	209.64	155.14	155.14
2043	-	9.12	8.70	11.05	28.87	209.52	41.90	251.43	222.56	164.69	164.69
2044	-	9.12	8.70	11.05	28.87	220.88	44.18	265.06	236.19	174.78	174.78
2045	-	9.12	8.70	11.05	28.87	232.87	46.57	279.45	250.58	185.43	185.43
2046	-	9.12	8.70	11.05	28.87	245.54	49.11	294.64	265.77	196.67	196.67
2047	(209.86)	9.12	9.84	11.05	30.01	258.91	51.78	310.69	280.68	207.70	(2.16)
2048	-	9.12	9.84	11.05	30.01	270.84	54.17	325.01	295.00	218.30	218.30
2049	-	9.12	9.84	11.05	30.01	283.35	56.67	340.02	310.01	229.41	229.41
2050	-	9.12	9.84	11.05	30.01	296.47	59.29	355.76	325.75	241.06	241.06
2051	-	9.12	9.84	11.05	30.01	310.23	62.05	372.27	342.26	253.27	253.27
2052	-	9.12	9.84	11.05	30.01	324.66	64.93	389.59	359.57	266.08	266.08
2053	-	9.12	9.84	11.05	30.01	339.79	67.96	407.75	377.73	279.52	279.52
2054	-	9.12	9.84	11.05	30.01	355.67	71.13	426.80	396.79	293.62	293.62
2055	-	9.12	9.84	11.05	30.01	372.33	74.47	446.79	416.78	308.42	308.42
2056	-	9.12	9.84	11.05	30.01	389.81	77.96	467.77	437.76	323.94	493.51
										FIRR	3.02%
										NPV	1013.30

³⁷ CMRL Annual Report 2020. <https://chennaietrail.org/wp-content/uploads/2019/05/CMRL-Annual-Report-ENGLISH-2019-20-5.pdf>

³⁸ The FIRR was calculated on an after-tax basis, assuming a tax rate of 26 percent. as per CMRL Annual Report 2019.

13. FIRR and the Project NPV's sensitivity to decrease in revenue, increase in capital and O&M cost is provided in Table A3.7. FIRR is more susceptible to a decrease in revenue (traffic or fare) than to an increase in capital or O&M costs.

Table A3.7: Financial Evaluation and Sensitivity Analysis

Scenario	Project FIRR	Project NPV (USD million)
Base Case	3.02%	1013.30
Decrease in annual fare escalation by 100 bps to 6.5% (nominal)	2.11%	425.10
Revenue decrease by 10%	2.44%	636.17
Increase in Capital Cost by 10%	2.57%	783.94
Increase in O&M Cost by 10%	2.95%	966.86
Increase in Capital Cost and O&M Cost by 10%	2.50%	737.50
Increase in Capital Cost and O&M Cost by 10% and reduction in revenue by 10%	1.92%	360.36
Increase in Capital Cost, O&M Cost by 10%, reduction in revenue by 10% & reduction in annual fare escalation by 100 bps to 6.5% (nominal)	1.00%	(169.02)

D. Weighted Average Cost of Capital (WACC)

14. The Project's financing plan will include funding from AIIB, and the parallel co-financiers, ADB and NDB, and GoTN. The cost of debt is estimated based on the aggregate margin over LIBOR, as per relevant average maturity bucket, for sovereign-backed loans published on websites of the respective co-financiers, plus swap rate for 6-month LIBOR (by interpolating 10- and 20-year swap rates) as per the Bloomberg data³⁹.

15. As per CMRL's audited financial statements for the year ended March 31, 2019, the tax rate is assumed to be 26 percent. The overall real, post-tax WACC for the Project is 1.32 percent, as presented in Table A3.8. The Project is currently being developed as a state sector project. CMRL has approached the Ministry of Housing and Urban Affairs, GoI to consider the Chennai Metro Phase 2 Project to be examined as a central sector project and to be considered for equity sharing between GOI and GoTN. GoTN shall consider infusing capital by way of non-interest-bearing fully subordinated debt if GoI approval is not forthcoming to ensure equitable ownership of CMRL between GoTN and GoI. This sub-debt is repayable only after all senior debt is fully satisfied. The assessment has been undertaken on a conservative basis, by assuming GoTN funding as equity instead of zero interest-bearing subordinated loan. The cost of equity is calculated as the current yield on 10-year GoI securities adjusted for tenure plus the yield premium for indebtedness of GoTN over the sovereign⁴⁰. It may be inferred from the WACC and the

³⁹ The door-to-door maturity of 25 years and average maturity of 12.5 years is assumed for WACC assessment.

⁴⁰ State Government Yield Spreads, Mint Street Memo No. 08, Reserve Bank of India dated December 08, 2017.

sensitivity analysis, the project economics is robust not only in base case but also in most of the stress cases.

Table A3.8: The Project's Estimated Weighted Average Cost of Capital (WACC)

Item	AIIB	ADB	NDB	GoTN	
A. Amount (\$ million)	356.67	467.46	346.72	1101.08	
B. Weightage (%)	15.70%	20.58%	15.26%	48.46%	
C. Nominal cost (%)*	2.84%	2.21%	2.76%	6.83%	
D. Tax rate (%)	26.00%	26.00%	26.00%	0.00%	
E. Tax-adjusted nominal cost [C*(1-D)]	2.10%	1.63%	2.04%	6.83%	
F. Inflation rate (%) #	2.30%	2.30%	2.30%	4.00%	
G. Real cost $[(1+E)/(1+F)-1]$ (%)	-0.20%	-0.65%	-0.25%	2.72%	
H. Minimum rate test (I = 0%)	0.00%	0.00%	0.00%	2.72%	
I. Weighted component of WACC	0.00%	0.00%	0.00%	1.32%	
WACC (Real terms)	1.32%				

US inflation is as per IMF Data mapper, Indian inflation is as per the amendment to RBI act dated May 14, 2016, and corresponding accepted recommendations of Urjit Patel committee report

*Method of arriving at Nominal cost for all co-financiers: For all lenders, swap rate for USD LIBOR 6 months for 12.5 years is ascertained by interpolating the same for 10 and 20 years sourced from Bloomberg for the last five trading sessions ended May 17, 2021. Fixed spread, upfront/ front-end fee, and commitment fee are added to the swap rate, as per the latest policies of the relevant lender, to arrive at "Nominal cost" for lenders.

Annex 4: Member and Sector Context

A. Country context

1. The Indian economy is expected to recover in FY2021. After growing at a healthy rate of 7.4 percent between FY2014 and FY2018, the Indian economy experienced a slowdown in recent years. Growth slowed down to 4.2 percent in FY2019 due to distress in the rural economy, financial sector stress weakness in private consumption, investment, and exports, owing to rural distress, the stress in the financial sector, and sluggish global demand. Growth in FY2020 was significantly dented by the COVID-19 outbreak and the associated lockdown, with economic output contracting by 8.0 percent. Growth is expected to strongly recover in FY2021.

2. The rapid pace of growth was accompanied by sustained growth in urbanization. The share of the urban population in the overall population increased from 27.8 percent in 2001 to 31.2 percent in 2011 and further to over 34.0 percent in 2018. The proportion is expected to grow to 43.0 percent by 2031 with Indian cities likely to contribute about 70% of GDP. Similarly, the number of metropolitan cities with a population of 1 million or more is expected to increase from 50 in 2011 to 87 by 2031. However, the rapid growth of the urban population was not matched with commensurate growth in urban infrastructure. The sharp rise in the infrastructure gap has manifested itself in traffic congestions, inadequate solid waste management facilities, drinking water scarcity, pollution, etc. The gap in urban infrastructure is estimated at USD 827 billion over the next 20 years.⁴¹

3. Urban sector infrastructure investments have been traditionally undertaken by the public sector. Central Schemes like Smart Cities, Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Swachh Bharat Mission, and Smart City Mission have bolstered public investment in the urban sector. Under AMRUT, more than 3,000 projects have been completed. The Government of India has also created a National Infrastructure Pipeline of Projects to fast-track infrastructure investments. The National Infrastructure Pipeline envisions completing 7,575 projects with a combined cost of USD 1.8 trillion by FY2025⁴². About two hundred of these projects are in the urban sector.

4. In addition to these schemes, the government has also introduced many policies in recent years to improve the state of urban transport infrastructure. The National Urban Transport Policy (2014) has emphasized providing sustainable mobility and accessibility to places of work education and services at affordable costs for the people. It calls for internalizing urban transport as a key input in urban planning exercises and suggests putting in place intelligent transport for

⁴¹ Background Paper for Global Review of Finance for Sustainable Urban Infrastructure, Coalition for Urban Transitions.

⁴² National Infrastructure Pipeline (www.investmentgrid.gov.in/national-infrastructure-pipeline), accessed April 8, 2021.

better traffic management and establishing institutional mechanisms and capacity building for better planning and management of transport systems.

5. The government, in its *Strategy for New India @75*, has outlined goals to expand the urban road network, improve the road, and reduce the number of road accidents by 50 percent by 2022-23. To achieve the aforementioned goals the government is taking a 9-pronged approach involving (a) expansion of the road network to improve connectivity, (b) improvement of road maintenance and safety, (c) streamlining land acquisition processes, (d) development of skills, (e) increasing the emphasis on research and development, (f) enhancement of public transport, (g) expansion of electronic toll collection, (h) completion of rural connectivity target and (i) increase of adoption of technology between different modes of transport. In terms of the enhancement of public transport, the government plans on transforming road transport undertakings and promote public transport, make more public funding available for public transportation and work with sub-national bodies to promote technology-enabled bus ports. Similarly, the government plans to convert public transport systems to electric in a time-bound manner.

6. Despite the ambitious targets, urban transport infrastructure has not been able to keep pace with its economic growth. This has resulted in road congestion, falling road speed, increasing air pollution, stretched road capacity, reduced road safety, and strained public transport systems.⁴³ Public transport systems often operate in silos and fragments as opposed to integrated systems. Expansion of the public transport fleets has been hampered by the short supply of vehicles as well as the lack of reforms of existing policies, which give preference to private vehicles and road expansion at the cost of public transportation strengthening. Lack of designated spaces for public motorized transport systems reduces their appeal in terms of time efficiency. Women face significant safety challenges in using public transport, which hampers their access to education and employment.

7. Tamil Nadu is the second largest contributor to India's economy after Maharashtra. It is one of the more developed states in India with a per capita income of INR 218,599 (USD 2,973) in FY2019; nearly 50% higher than the national average. Moreover, Tamil Nadu is the most urbanized large state of India with an urban population accounting for 48.4 percent of the total population in 2011, which is expected to rise to 63 percent by 2030. The majority of the state's GDP is generated in urban areas as reflected in the services and industry sector accounting for nearly 88 percent of the state's GDP. As in the case of other states in India, buses are the most common form of public transport. More than 20,000 bus fleets are operating in the state. The public transport system has not been able to keep up with the pace of urbanization. Citizens are forced to use modes of private transport, which results in a higher degree of congestions and accidents. Estimates indicate that in Chennai, the capital city, the average vehicle movement speed fell from 30 km per hour in 1993 to 19 km per hour in 2017. A rise in private vehicles has

⁴³ India Urban Infrastructure Report 2020, Knight Frank Research

caused total accidents to increase from 5060 in 2009 to 7257 in 2017, while fatal accidents have increased from 582 to 1264 over the same period.

8. The state's capital, Chennai, is located on the shores of the Bay of Bengal and is the fourth largest city in India. It has grown as a base for the automobile, information technology, hardware manufacturing, and health care industries. As one of the world's fastest-growing cities, Chennai's economy is projected to grow by more than 8% annually from 2019 to 2035. However, the city has been vulnerable to climate change, natural disasters, and more recently, the COVID-19 pandemic. Floods of 2016, Cyclone Gaja in 2018, droughts in 2018 and 2019, and the COVID-19 pandemic have brought about significant economic and life losses and have negatively affected infrastructure and service delivery.

B. Sector and Institutional Context

9. The current transportation system in Chennai Metropolitan Area (CMA) is marked by high traffic density, carbon emissions, and frequent road accidents. In addition to the high volume of vehicles and already congested roads, inadequate parking space and the encroachment of street space by vendors on the major road have exacerbated traffic congestion. The growth in the use of private vehicles has put Chennai in fifth place in carbon emission from the transport sector among 54 South Asian cities.⁴⁴ Chennai also recorded the highest number of road incidents in India, with a staggering 7,846 cases recorded in 2016.⁴⁵

10. Chennai offers multiple modes of public transportation including metro rail, suburban rail, and buses – although these operate in isolation with separate ticketing systems and poor integration between the modes. In 2011, the Chennai Unified Metropolitan Transport Authority (CUMTA) Act was passed with the objective of integrating the entire network under a single operator. However, the Act and CUMTA rules came into force in 2019.

11. Inadequate transportation infrastructure and poor maintenance have resulted in a marked decrease in the share of the use of public transportation from 54 percent in 1970 to 28 percent in 2014.⁴⁶ The Chennai Second Master Plan 2026 proposes to increase the public and private mode split to 70:30. Mass transit, especially an integrated metro system, will be essential to achieve the target modality split.

12. Chennai's metro rail system began operations in 2015 with a first phase spanning 54km in two corridors linking the northern and southern parts of the city, including a connection to the Chennai Airport. It was financed by the GoI, GoTN, and JICA. The second phase of the metro rail system, which features three additional corridors, is now under development with AIIB

⁴⁴ International Council for Local Environmental Initiative Study, 2012.

⁴⁵ Accidental Death and Suicides in India (ADSI), National Crime Records Bureau, 2016.

⁴⁶ Comprehensive Detailed Project Report for Chennai Metro Phase-II, Chennai Metro Rail Limited, December 2018.

participating as a potential financier for corridors four and five. The metro rail system is implemented, operated, and maintained by Chennai Metro Rail Limited (CMRL).

13. **Institutional context.** The metro rail system in Chennai is operated by Chennai Metro Rail Limited (CMRL), a joint venture of the Government of India (GoI) and the Government of Tamil Nadu (GoTN) with equal equity ownership. In 2015, CMRL developed the comprehensive mobility plan for CMA according to present and future mobility patterns and identified three corridors (corridors 3, 4, and 5) for the second phase of the Chennai metro rail to alleviate growing transportation capacity constraints.

14. Separately, the elevated metropolitan railway in Chennai is operated by the Mass Rapid Transit System (MRTS), a state-owned subsidiary of the Indian Railway. MRTS is operated by Southern Railway, which also operates the Chennai Suburban Railway as part of a broader urban rail network. The public bus network in Chennai is operated by the Metropolitan Transport Corporation (MTC). These different agencies coordinate with the Chennai Metropolitan Development Authority (CMDA) for activities like land acquisition for expansion purposes.

15. The Chennai Unified Metropolitan Transport Authority (CUMTA) should serve as the unified transport authority in Chennai. The basis for a unified transport authority was introduced by the Central Government in 2006 in the National Urban Transport Policy (NUTP), which aimed to build sustainable urban transport in Indian cities, among other objectives. NUTP recommended that a Unified Metropolitan Transport Authority (UMTA) be established in every city with a population of over one million. Subsequently, GoTN passed the CUMTA Act in 2011. However, a decade later, CUMTA remains to be operationalized with the different agencies continuing to operate different modes of transportation separately.⁴⁷ CUMTA has many benefits including the integration across the urban transport on the physical, network, fare, information, geographical and institutional aspects.

⁴⁷ The News Minute. *Why Chennai's dream of a single transport authority remains unfulfilled*. 29 January 2020. <https://www.thenewsminute.com/article/why-chennai-s-dream-single-transport-authority-remains-unfulfilled-117073>

Annex 5: Sovereign Credit Fact Sheet.

A. Recent Economic Development

1. India is a lower-middle-income country, with a GDP per capita at USD 2,100 and a population of 1.37 billion in 2019.⁴⁸ It is the world's third-largest economy by purchasing power parity. India's economy grew at an average annual rate of 7.4 percent between FY2014 and FY2018 but has slowed down in recent years.⁴⁹ Following disruptions due to the demonetization initiative in November 2016 and the teething issues associated with the rollout of goods and services tax in July 2017, growth slowed to 7.0 percent in FY2017 and 6.1 percent in FY2018.⁵⁰ Growth further slowed down to 4.2 percent in FY2019 due to weakness in private consumption, investment, and exports, owing to rural distress, the stress in the financial sector, and sluggish global demand. The Indian economy contracted by 8 percent in FY2020 because of the COVID-19 pandemic and resulting lockdown.⁵¹ The economy showed signs of revival in the last two quarters of FY2020 as the lockdown measures were gradually eased.

2. Inflation averaged 6.2 percent in the FY2020, above the target band of 2-6 percent, primarily driven by food inflation due to supply-side disruptions. Inflation eased a bit in the last quarter of FY2020 as an easing of restrictions reduced the disruptions in supply chains. Despite higher-than-expected inflation, the central bank reduced the repo and reverse repo rates by 115 and 155 basis points to 4.0 and 3.35 percent respectively, to stimulate aggregate demand, which had declined due to the lockdown. The central bank introduced several measures to reduce the borrowing cost, bolster liquidity, and improve credit flow to the productive sectors.

3. General government fiscal deficit is estimated to have risen to 12.3 percent of GDP in FY2020. A downturn in revenue due to the economic slowdown and higher spending on the stimulus package resulted in the fiscal deficit widening significantly. Recognizing that an expansionary fiscal policy is required to mitigate the economic effect of the COVID-19 pandemic, the central government announced several fiscal support measures in FY2020. Various states have also announced additional relief measures. The anticipated economic contraction in FY2020 has adversely impacted tax collections. The burgeoning fiscal deficit and a contraction in GDP resulted in the public debt rising to close to 90 percent of GDP in FY2020.

4. The current account posted a surplus in FY2020, for the first time since 2002, thanks to a greater decline in imports as compared to exports. Suppressed demand and low oil prices

⁴⁸ The income group classification for fiscal year 2019 is based on World Bank criteria.

⁴⁹ Data is based on fiscal years. Fiscal year 2020 (FY2020) begins on 1 April 2020 and ends on 31 March 2021.

⁵⁰ On Nov. 8, 2016, India's government announced withdrawal of the legal tender of INR500 and INR1,000 notes, which accounted for 86 percent of the value of currency in circulation, and introduction of new INR500 and INR2,000 notes.

⁵¹ On March 24, the government announced a nationwide lockdown till April 14, subsequently extended to May 30. Lockdown was eased beginning June 1.

contributed to a reduction in the import bill whereas contraction in global demand led to the reduction in export earnings.

5. In June 2020, Moody’s downgraded India’s rating to Baa3 with a negative outlook while Fitch revised India’s outlook to negative, due to slow reform momentum and challenging economic environment, limited fiscal space, and stress in the financial sector.

B. Economic Indicators

Selected Macroeconomic indicators (2018-2022)

Economic Indicators	FY2018	FY2019	FY2020	FY2021*	FY2022*
Real GDP growth	6.5	4.0	-8.0	12.5	6.9
CPI Inflation (average, % change)	3.4	4.8	6.2	4.9	4.1
Current account balance (% of GDP)	-2.1	-0.9	1.0	-1.2	-1.6
General government overall balance (% of GDP)	-6.3	-7.4	-12.3	-10.0	-9.1
General government gross debt (% of GDP)	70.2	73.9	89.6	86.6	86.3
Public gross financing needs (% of GDP)	10.5	11.4	16.7	14.2	13.2
External debt (% of GDP)	20.1	19.8	20.6		
Gross external financing need (% of GDP) 1/	10.4	10	8.9	11.0	11.2
Gross international reserves (USD billions) 2/	415.8	481.3	581.1	589.5	
Exchange rate (INR/USD, EOP) 2/	69.6	71.4	73.0	73.4	

Note: FY 2020 ran from April 1, 2020, to March 31, 2021

* Denotes projected figures.

1/Data for 2021-22 are AIIB Staff Projections based on IMF

2/Reserves and exchange rate for FY2021 are sourced from RBI and pertain to May 2021.

Source: IMF World Economic Outlook April 2021, Reserve Bank of India, and IMF Country Report 19/385.unless otherwise stated

C. Economic Outlook and Risks

6. India is expected to grow at 12.5 percent in FY2021 aided by a low base and the effects of the fiscal stimulus kicking in. Domestic demand is expected to lead the recovery via the release of suppressed private consumption. Similarly, private investment is expected to pick up amidst improving business sentiment and credit conditions. However, increasing NPLs and the uncertainties regarding the length of the pandemic may constrain bank lending. An increase in public investment, primarily via an increase in capital expenditure, is also expected to support recovery. The surge in COVID-19 cases across India in the first quarter of FY2021 and the associated lockdown in many states could dent the extent of economic recovery. However, with the lockdown measures being more localized in FY2021, the impact is expected to be muted.

7. Overall inflation is expected to decrease to 4.9 percent in FY2021, as supply chains recover and agriculture output increases. However, an increase in oil prices could lead to a resurgence of inflationary pressures.

8. Fiscal deficit in FY2021 is expected to moderate to 10 percent of GDP as tax revenue increases on the back of improved economic activity. Efforts taken by the central government to increase tax compliance and revenue collection are also expected to bolster revenue performance. The federal government proposes to invest heavily in infrastructure in FY2021 with capital expenditure scheduled to increase by more than 26.0 percent focusing on housing, roads, railways, and telecom.
9. Public debt, which was estimated to rise sharply to 89.3 percent of GDP in FY2020, levels last witnessed in the early 2000s, is expected to decline to 86.8 percent. Despite being high, India's public debt remains sustainable given favorable debt dynamics and the projected increasing economic growth trend in the medium term. Furthermore, with public debt having a long and medium maturity, being denominated in domestic currency, and primarily held by residents, the debt profile is favorable. India's external debt is expected to remain stable.
10. The current account balance is projected to return to the deficit as import growth is expected to outpace export growth. An increase in oil prices is expected to exacerbate the trade deficit. Remittances are also expected to pick up as Middle East economies recover and the spread of the COVID-19 pandemic in advanced economies is contained.