ADB

Report and Recommendation of the President to the Board of Directors

Project Number: 49107-009
September 2021

Proposed Loan
India: Integrated Urban Flood Management for the Chennai–Kosasthalaiyar Basin Project

Asian Development Bank

CURRENCY EQUIVALENTS
(as of 15 August 2021)

Currency unit	–	Indian rupee/s (₹)
₹1.00	=	$0.013
$1.00	=	₹74.16

ABBREVIATIONS

ADB	–	Asian Development Bank
COVID-19	–	coronavirus disease
GCC	–	Greater Chennai Corporation
GEF	–	Global Environment Facility
IEE	–	initial environmental examination
O&M	–	operation and maintenance
PAM	–	project administration manual
PBI	–	performance-based incentive
RCP	–	Representative Concentration Pathway
WASH	–	water, sanitation, and hygiene

WEIGHTS AND MEASURES

km	–	kilometer
km^2	–	square kilometer
m	–	meter
mm	–	millimeter

NOTES

(i) The fiscal year (FY) of the Government of India and its agencies ends on 31 March. "FY" before a calendar year denotes the year in which the fiscal year ends, e.g., FY2022 ends on 31 March 2022.

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

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CONTENTS

PROJECT AT A GLANCE

1. Basic Data

Project Number: 49107-009

Project Name	Integrated Urban Flood Management for the Chennai-Kosasthalaiyar Basin Project
Country	India
Borrower	India
Country Economic Indicators	https://www.adb.org/Documents/LinkedDocs/?id=49107-009-CEI
Portfolio at a Glance	https://www.adb.org/Documents/LinkedDocs/?id=49107-009-PortAtaGlance
Department/Division	SARD/SAUW
Executing Agency	Municipal Administration and Water Supply Dep't

2. Sector

	Subsector(s)	ADB Financing ($ million)
✓ **Water and other urban infrastructure and services**	Urban flood protection	251.00
	Total	**251.00**

3. Operational Priorities

- ✓ Addressing remaining poverty and reducing inequalities
- ✓ Accelerating progress in gender equality
- ✓ Tackling climate change, building climate and disaster resilience, and enhancing environmental sustainability
- ✓ Making cities more livable
- ✓ Strengthening governance and institutional capacity

Climate Change Information

GHG reductions (tons per annum)	0.000
Climate Change impact on the Project	High

ADB Financing

Adaptation ($ million)	87.00
Mitigation ($ million)	0.00

Cofinancing

Adaptation ($ million)	0.00
Mitigation ($ million)	0.00

Sustainable Development Goals

SDG 1.5
SDG 5.5
SDG 11.5
SDG 13.a

Gender Equity and Mainstreaming

Effective gender mainstreaming (EGM) ✓

Poverty Targeting

General Intervention on Poverty ✓

4. Risk Categorization: Complex

5. Safeguard Categorization

Environment: B **Involuntary Resettlement:** B **Indigenous Peoples:** C

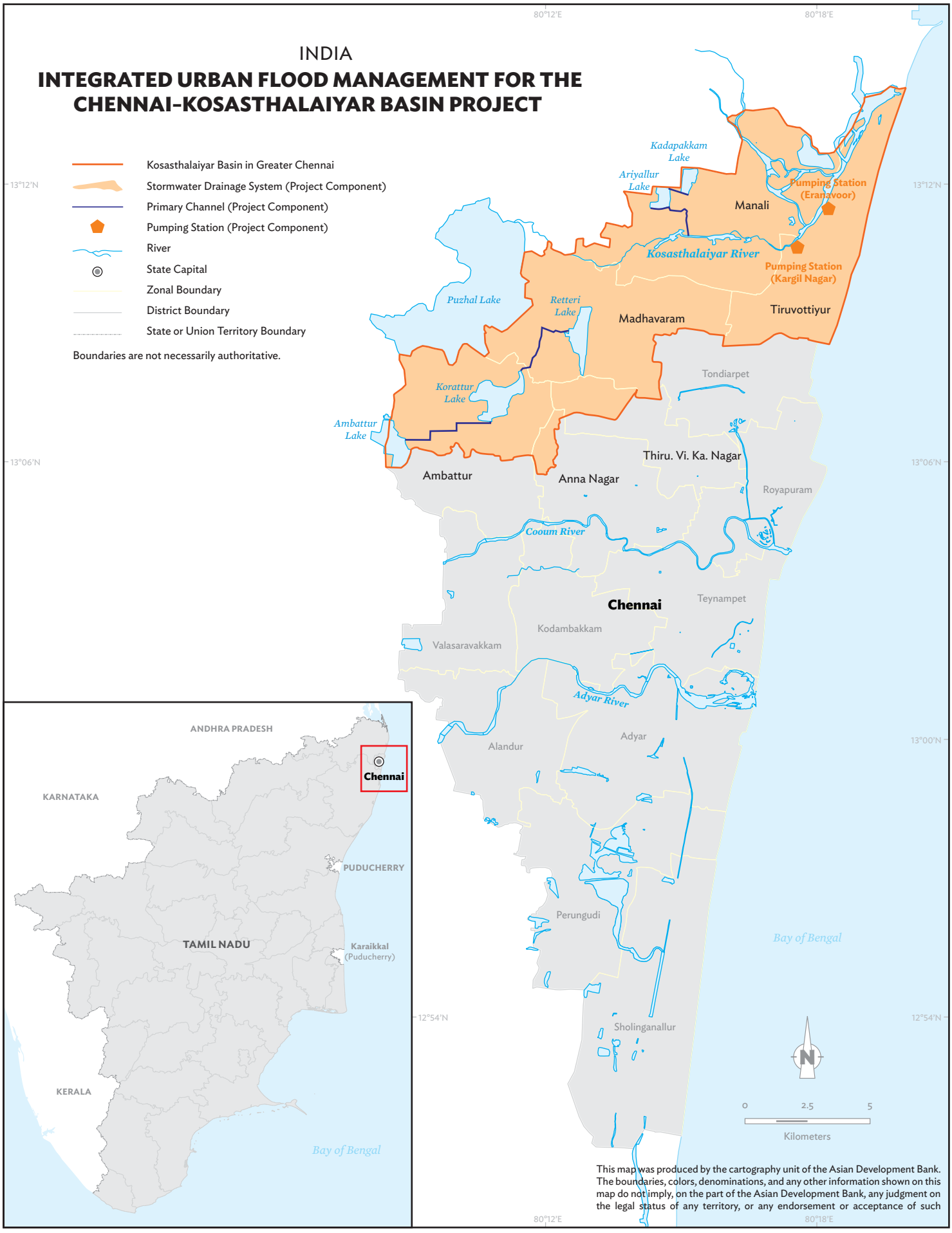
6. Financing

Modality and Sources	Amount ($ million)
ADB	**251.00**
Sovereign Project (Regular Loan): Ordinary capital resources	251.00
Cofinancing	**0.00**
None	0.00
Counterpart	**219.50**
Government	219.50
Total	**470.50**

Currency of ADB Financing: US Dollar

INDIA

INTEGRATED URBAN FLOOD MANAGEMENT FOR THE CHENNAI–KOSASTHALAIYAR BASIN PROJECT



This map was produced by the cartography unit of the Asian Development Bank. The boundaries, colors, denominations, and any other information shown on this map do not imply, on the part of the Asian Development Bank, any judgment on the legal status of any territory, or any endorsement or acceptance of such

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I. THE PROPOSAL

1. I submit for your approval the following report and recommendation on a proposed loan to India for the Integrated Urban Flood Management for the Chennai–Kosasthalaiyar Basin Project.

2. The project will strengthen climate and disaster resilience in the Chennai–Kosasthalaiyar River basin. It will reduce the exposure of 1.9 million people to seasonal flooding by (i) improving climate-resilient urban flood protection infrastructure; (ii) enhancing urban flood preparedness of the Greater Chennai Corporation (GCC), the civic body that governs the city of Chennai, and project communities; and (iii) establishing measures for sustaining the operation and maintenance (O&M) of the stormwater drainage system in the GCC.[1]

II. THE PROJECT

A. Rationale

3. **Vulnerability of an urban economic center.** Chennai is the fourth largest metropolitan area in India, with an estimated population of 10.7 million.[2] The population density is about 26,000 persons per square kilometer (km^2), with a high concentration of businesses and industries. It is one of India's fastest-growing major cities, with an annual economic growth rate of 6%. Its economy has diversified substantially over the past 2 decades, now including automobile, information technology, and health care industries; financial services; and post-secondary educational institutions, as well as a manufacturing base producing various other types of hardware. Automobile and electronic goods are important export-oriented industries, making Chennai the largest exporting hub in India. The city is in the East Coast Economic Corridor—India's first coastal corridor, as defined by the Government of India and the Asian Development Bank (ADB)—stretching more than 2,500 kilometers (km) from West Bengal to Tamil Nadu to stimulate economic growth by promoting manufacturing and creating jobs.[3] Chennai is a key player in the state and national economies, contributing 60% of Tamil Nadu's manufacturing output and 60% of India's automotive exports.[4]

4. While rapid urbanization has fueled the local economy, the city is challenged to keep pace with demand for urban services while protecting its fragile environment. Chennai's jurisdiction expanded in 2011 from 174 km^2 to 426 km^2. An increasing number of migrant workers have settled in the city and its suburbs,[5] and slums have grown to house 18.9% of the city's population.[6] Lack of appropriate planning has allowed urban expansion to alter the natural landscape and land use, shrinking water bodies and expanding impermeable areas. The water retention capacity of the city's water bodies is reduced through increased encroachment and unplanned area

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[1] The GCC is headed by a mayor and legally distinct from the state government. It is mandated to provide and maintain drainage systems within its boundaries following the Chennai City Municipal Corporation Act, 1919.

[2] The population is projected using the Census 2011 figure of 8.9 million people and 2.32% annual growth. United Nations, Department of Economic and Social Affairs, Population Division. 2019. *World Urbanization Prospects: The 2018 Revision*. New York.

[3] The East Coast Economic Corridor incorporates the Visakhapatnam–Chennai and Chennai–Kanyakumari industrial corridors. ADB supports its integrated, multidisciplinary, and cross-sector development.

[4] Resilient Chennai. 2019. *Chennai City Resilience Strategy 2019*. Chennai; and Resilient Chennai. 2018. *Preliminary Resilience Assessment.* Chennai.

[5] Some 575,000 interstate migrants work in Chennai, Kancheepuram, and Tiruvallur districts. They work predominantly in the manufacturing, garment, construction, and hotel industries. Resilient Chennai. 2019. *Discovery Area Report: Informal Settlements—Vulnerable and Low Income Groups*. Chennai.

[6] Government of Tamil Nadu, State Planning Commission. 2017. *District Human Development Report, 2017: Chennai District*. Chennai.

development, with little consideration of hydrology. Half of the 19 major water bodies in the city have been encroached upon, severely limiting the available surface water storage potential and its ability to mitigate the impacts of extreme weather events. Such environmental degradation heightens the risk of widespread damage and loss to the economy and livelihoods from flooding. Industrial enterprises are exposed to worsening risks of severe asset damage and income loss from prolonged inundation, undercutting the area's ability to attract investment. Many slum residents live in substandard housing in flood-prone zones. Their average family income is less than half of non-slum households' income.[7] With limited access to basic services, urban low-income households lack the capacity to cope with floods.

5. **Increasing flood risk with extreme weather events.** Chennai is located on the highly exposed southeast coast of India and is relatively low and flat, with average elevation of 6.7 meters (m) above sea level. Three major rivers—the Adyar, Cooum, and Kosasthalaiyar—traverse a coastal bowl, which frequently inundates following even short periods of rain. In the past decade, the city has endured more frequent and intense flood and drought extremes. In 2015, Chennai recorded rainfall depth of 348 millimeters (mm) over a 24-hour period, exceeding the 1:100-year annual recurrence interval rainfall depth estimate, following multiple torrential rainfall events in the course of a month. This caused severe flooding, which claimed more than 400 lives.[8] Of the 859 locations across the city inundated during the flood, 306 reported inundation depths of 0.6–1.5 m for more than 10 days. More than 12,000 residents of Chennai were sheltered in 170 relief centers for more than 20 days.[9] The floods destroyed property and livelihoods, particularly of the poor and other vulnerable groups residing next to water bodies. Impacts on the environment and public health were high, as sanitation worsened and vector-borne, waterborne, and airborne diseases spread.[10]

6. The Climate Change Vulnerability Index of 2021 ranks Chennai the highest among large Indian cities in terms of exposure to climate change-related threats.[11] Another study shows that Chennai is ranked the most socioeconomically vulnerable to climate change among the metropolitan cities in India.[12] The risk of flooding in Chennai is expected to worsen with climate change. Climate models project an 11% increase in heavy rainfall under the Representative Concentration Pathway (RCP) 4.5 and 16% under the RCP 8.5 to 2050, which will likely cause more frequent and damaging floods if drainage infrastructure is not improved. The rise in sea level, projected at 4–6 mm per year under the RCP 4.5 and 8.5 to 2050, will worsen coastal flooding and the tide-locking of drainage outlets, requiring greater drainage capacity. Higher storm surges from tropical cyclones can prevent the free drainage of stormwater and increase reliance on pumping. Higher temperatures and more frequent droughts are expected to exacerbate water scarcity in the city. These issues are identified in the Tamil Nadu State Action Plan on Climate

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[7] The average monthly family income of slum households in Chennai is ₹11,394, while that of non-slum households is ₹27,044. ADB. 2017. *Baseline Socio Economic Survey for the Project Towns of the MFF Tamil Nadu Urban Flagship Investment Program.* Consultant's report. Manila.

[8] Total economic losses in India were estimated to reach $3 billion. AON. 2015. Indian Economy Suffers $3bn Loss from Persistent Floods Amid Low Insurance Penetration, According to AON Catastrophe Report. 10 December.

[9] Greater Chennai Corporation. 2017. *City Disaster Management Plan*. Chennai.

[10] R. Amarnath, S. Jenitha, and G. Verma. 2016. Health Impacts After the Century's Worst Flood in Chennai: A Prospective Telemedicine Study. *Research Journal of Pharmaceutical, Biological and Chemical Sciences.* 7(3). pp.1073–1084.

[11] Verisk Maplecroft. 2021. *Environmental Risk Outlook 2021.* Bath.

[12] The Indian Institute of Technology-Bombay ranked 11 Indian cities by developing a socioeconomic vulnerability index based on the weightage given to infrastructure, technology, space, social, and financial aspects. Chennai is ranked the third most vulnerable city of all and the first among the metropolitan cities. K. Malakar and T. Mishra. 2017. Assessing Socio-Economic Vulnerability to Climate Change: A City-Level Index-Based Approach. *Climate and Development.* 9(4). pp. 348–363.

Change and the GCC City Disaster Management Plan (footnote 9), which call for structural and nonstructural measures to strengthen resilience, including better stormwater drainage, the protection of urban wetlands, water harvesting, and risk-sensitive land use planning.[13]

7. **Challenges to strengthening climate and disaster resilience in the Chennai–Kosasthalaiyar basin.** The Kosasthalaiyar River basin spans 3,757 km^2 across two states: Tamil Nadu and Andhra Pradesh. The basin within the boundaries of the GCC, called the Chennai–Kosasthalaiyar basin, measures 128 km^2 and covers 30% of the GCC land area. Most of this area was added to the GCC when it expanded in 2011. A review of land use shows that most new development in Greater Chennai occurs in this area and includes a high concentration of industry, raising demand for land for both industrial plants and housing. Further growth is expected as the GCC improves connectivity to city business centers. With rapid urbanization, floodwater retention capacity is constrained and diminished by (i) reduced groundwater infiltration capacity with the spread of impermeable surfaces, reduced green cover, and degraded ecosystem services; (ii) inadequate and deteriorating flood protection infrastructure such as stormwater drains, water storage bodies, large channels linking water bodies, and pump stations;[14] and (iii) inadequate O&M of flood management infrastructure because of poor asset management, lack of performance monitoring, and insufficient O&M budget allocation. Further, flood risk management is inadequate as (i) urban land use planning and development control regulations, such as flood zoning regulations, do not sufficiently recognize current and future hazards; (ii) flood forecasting and early warning systems are limited; and (iii) capacity and awareness shortfalls render the GCC and city residents unable to respond quickly to flooding.

8. Consequently, about 63% of the Chennai–Kosasthalaiyar basin is flood-prone, with 15.9 km^2 highly or very highly vulnerable.[15] In 2015, floods inundated more than 80% of the project area. Only about one-third of the area has drains, and some places have inadequate capacity to convey flood flows likely to occur once every 2 years (1:2-year return period). Industries and residents are increasingly vulnerable to frequent, intense, hazardous, and destructive floods. Climate change can have knock-on effects on industrial supply chains. Severe flooding disrupts manufacturing operations in low-lying areas and interrupts physical distribution to downstream companies. Ensuring business continuity requires additional costs and contingent logistics, adversely impacting small businesses. Slum dwellers are susceptible to loss of livelihood because of their low flood risk awareness and limited access to basic services and job opportunities. Women suffer disproportionately from floods, reflecting their limited involvement in decision-making within their communities and potential discrimination against them at shelters. Recognizing these socioeconomic impacts and the complex meteorologic and hydrologic causes of flooding in the Chennai–Kosasthalaiyar basin, strengthening flood resilience requires robust and holistic approaches to flood risk management. Interventions should be adaptive to future uncertainty by optimally combining (i) structural measures to reduce flood risk by controlling the flow of water through hard-engineered structures and green solutions, and (ii) nonstructural measures to keep people safe from floods through improved preparedness planning and promoting behavioral change to build resilience over the long-term. Along with climate-resilient infrastructure, Chennai City requires integrated urban planning linking flood hazard zoning with land use planning and enhancing the municipal resource mobilization, to ensure the sustainable provision of quality services to the citizens.

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[13] Government of Tamil Nadu. 2014. *State Action Plan on Climate Change: Towards Balanced Growth and Resilience*. Chennai.

[14] Most drains in the Chennai–Kosasthalaiyar basin were constructed 2 decades ago. A nearby canal in low-lying coastal areas is elevated above the lowest part of the catchment, worsening floods in 2015.

[15] Very high vulnerability is defined as inundation above 1.5 m and high vulnerability above 0.9–1.5 m.

9. **Government strategy.** A strong rationale supports government involvement in reducing climate and disaster risk to communities and businesses. The Tamil Nadu Vision 2023 and the Tamil Nadu Sustainable Water Security Mission envisage a more resilient future by ensuring more strategic, holistic, and integrated interventions to address the interconnected problems that cause floods.[16] The GCC, in its City Disaster Management Plan, envisions enhanced disaster preparedness to maximize its ability to cope with disasters and significantly reduce the loss of lives, livelihoods, and property (footnote 9). The GCC prioritizes the restoration and protection of its water bodies to boost their stormwater retention capacity by recharging the groundwater aquifer. The World Bank has supported GCC efforts to improve drainage in the Adyar and Cooum river basins in the central zone and will develop an early flood warning system for the entire Chennai metropolitan area. German development cooperation through KfW finances the improvement of stormwater drainage systems in the Kovalam River basin in southern Chennai. Given the city's high climate hazard risks, the governments of India and Tamil Nadu have requested ADB support to strengthen the stormwater drainage network in the remaining river basin, the Kosasthalaiyar.

10. **Lessons.** Global experience has shown that (i) flood risk management should be integrated with urban planning and management, (ii) combining structural and nonstructural measures is the most effective strategy to manage flood risk, (iii) flood management measures can have multiple co-benefits from nature-based solution such as increased amenity value and biodiversity improved by the greening of urban spaces and water body rejuvenation, and (iv) adequate O&M of flood management assets is key to sustainable management.[17] An ADB regional working paper suggests an integrated urban management approach in which urban stormwater management is supported by the management of other urban utilities, such as sewage collection and treatment, and solid waste collection and disposal.[18] Urban flood management projects in Kolkata supported by ADB have shown that awareness campaigns effectively improve people's preparedness for flooding.[19]

B. Project Description

11. The project is aligned with the following impact: Chennai City made a safe place to live in, with reduced vulnerability to disaster (footnote 9). The project will have the following outcome: climate and disaster resilience in the Chennai–Kosasthalaiyar River basin strengthened.[20]

12. **Output 1: Climate-resilient urban flood protection infrastructure improved in the Chennai–Kosasthalaiyar River basin.** This will include structural measures such as (i) constructing 588 km of new stormwater drains; (ii) rehabilitating or replacing 175 km of stormwater drains; (iii) improving 11 km stretches in the Ambattur, Ariyallur, Kadappakkam, and

[16] Government of Tamil Nadu. 2012. *Vision Tamil Nadu 2023: Strategic Plan for Infrastructure Development in Tamil Nadu*. Chennai; and Government of Tamil Nadu. 2015. *Tamil Nadu Sustainable Water Security Mission*. Chennai. The Tami Nadu Municipal Administration and Water Supply Department provides policy guidance on urban flood management and, in coordination with other state departments, supports coordinating various government programs and projects. In the field, urban local bodies are critical in mitigating urban flooding.

[17] A. Jha, R. Bloch, and J. Lamond. 2012. *Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century*. Washington, DC: World Bank.

[18] R. Osti. 2018. Integrating Flood and Environmental Risk Management: Principles and Practices. *ADB East Asia Working Paper Series.* No. 15. Manila: ADB.

[19] N. Pokhrel. 2019. *Transforming Kolkata: A Partnership for a More Sustainable, Inclusive, and Resilient City*. Manila: ADB.

[20] The design and monitoring framework is in Appendix 1.

Korattur channels to enhance water-carrying capacity;[21] (iv) constructing one new stormwater pumping station and upgrading one pumping station; (v) constructing 23,000 catchpits at regular intervals in roadside drains to recharge the groundwater aquifer; and (vi) rehabilitating four disaster relief camps and ensuring these are gender-responsive and socially inclusive.[22] The flood modeling adopted in the designs ensures that the proposed stormwater drains can safely convey stormwater flow from 1:2-year return period rainfall, with a provision to cope with 79 mm per hour and a sea level rise of 21.7 centimeters under the RCP 8.5 scenario to 2050.[23] The hydraulic design of four surplus channels has the capacity to cope with 1:5-year floods, providing safe floodwater discharge during the worst-case scenario—combining increased precipitation, a projected sea level rise, and a storm surge caused by a cyclone.

13. **Output 2: Urban flood preparedness of the Greater Chennai Corporation and project communities enhanced.** This will include the following nonstructural measures: (i) GCC endorsement of guidelines on integrating flood hazard zoning with spatial plans and land use, building, and development regulations; (ii) the establishment of the baseline flood resilience index to identify the flood vulnerability, target priority interventions, and establish a framework for continuous improvement throughout Chennai City; (iii) the operationalization of a flood citizen observatory with a software platform to obtain real-time information in flood areas, water levels, and damage; (iv) GCC endorsement of a manual for green infrastructure design, including rainwater harvesting; (v) knowledge enhancement in the community, including for women, of the benefits of green infrastructure, including rainwater harvesting; (vi) raised beneficiary awareness of flood risks and impacts and the links that connect flooding, solid waste management, house sewerage connections, and the protection of water bodies, including activities targeting women; and (vii) improved GCC staff capacity to plan and design stormwater drainage systems in coordination with the management of solid waste and flood risk. Lessons and good practices from the project will be packaged into knowledge products and shared with key government officials and sector experts to further promote integrated flood management.

14. **Output 3: Measures for sustaining operation and maintenance of stormwater drainage system established in the Greater Chennai Corporation.** This will include (i) performance-based incentives (PBIs) for zonal offices linked to operational efficiency and the sustainability of stormwater drainage systems; (ii) a plan formulated to improve the sustainable and inclusive O&M of stormwater drainage systems; (iii) a road map for enhancing municipal resource mobilization by the GCC; (iv) improved knowledge of GCC staff on sustainable O&M of drainage systems, and management of solid waste and flood risk; and (v) improved knowledge and skills of desilting and conservancy workers on cleaning and maintaining stormwater drainage

[21] These are surplus channels that constitute the primary drainage system, receiving runoff from one or more sub-basins and carrying it to the final discharge points.

[22] A gender-responsive and socially inclusive relief camp will have the following features: (i) at least one female worker or caretaker with supplies of sanitary napkins, soap, and a basic first aid kit with medicines; (ii) safe spaces (affording privacy and security) for women, especially nursing mothers and adolescent girls; (iii) well-lit and clean toilets for men and women, with barrier-free access for people with disabilities and older persons; water, hooks, ledges, and shelves in the toilet; and provisions for washing and disposal of menstrual products; (iv) regular (daily) visits by female student volunteers and awareness generation on women's vulnerability to violence and trafficking; (v) regular interaction between volunteers and people with disabilities within the relief camp; and (vi) helpline numbers displayed on walls.

[23] The design adopts a 1:2-year return period in line with national standards (2013) at the time of design stage and design standards adopted for other drainage basins in the GCC area, able to handle rainfall intensity of 68 mm per hour. As Chennai is at high risk from climate change (paras. 5 to 8), the drain design was tested for climate change impacts under an RCP 8.5 scenario and found to safely withstand the projected impact by 2050, or rainfall intensity of 79 mm per hour. The proposed stormwater drains will be covered with curb inlets or inlets from the rainwater catchpits through gratings. This will help in avoiding solid waste choking the drains and reducing the water-carrying capacity.

systems. The PBIs will be awarded based on a reporting system and database of key performance indicators for all zonal offices that will be established by 2023, with a focus on improving GCC management of drainage systems with timely maintenance services. The incentive payments will be used for additional activities that support the project's objective.[24] The Sustainable O&M Improvement Plan will enable the GCC to ensure adequate O&M of the created assets, based on the newly established asset management system and the experiences of the PBI program. The Road Map for Enhanced Municipal Resource Mobilization will provide a strategic implementation plan to improve revenue management in terms of revenue coverage, valuation, liability, collection, and taxpayer services; strengthen information interlinkage with other utilities; and promote digital transformation with enhanced data analytics. With robust economic growth and rising populations, the GCC is poised to increase its own municipal revenues. The road map will help it create an enabling framework for efficient, equitable, and accountable revenue management while phasing in improvements that are socially acceptable and operationally efficient.

15. **Alignment with ADB priorities.** The project aligns with ADB Strategy 2030 by supporting key operational priorities: addressing remaining poverty and reducing inequalities; accelerating progress in gender equality; tackling climate change, building climate and disaster resilience, and enhancing environmental sustainability; making cities more livable; and strengthening governance and institutional capacity.[25] It aligns with the water security policy recommendations of the *Asian Water Development Outlook 2020* by promoting urban water security through mitigation of disaster risk especially for the urban poor, and strengthening preparedness and resilience to counter current and future water-related disasters.[26] The project reinforces pillars 2 and 3 of ADB's country partnership strategy for India, 2018–2022 by supporting inclusive urbanization and improving climate and disaster resilience.[27] It aligns with ADB's strategic priority in the East Coast Economic Corridor by providing disaster-resilient infrastructure (para. 3).

C. Value Added by ADB

16. The project is synergetic with the initiatives of other development partners in Chennai that invest in flood reduction infrastructure (para. 9) and help the GCC to upgrade its flood management system in coordination with proposed support from the World Bank and the Japan International Cooperation Agency.[28] The proposed integrated urban flood management has reflected the knowledge and experiences of these partners gained from their past and on-going interventions. It also complements with ongoing ADB multitranche financing facility interventions in Chennai to improve water supply and sewerage management in the project area, mitigate drought risk, and protect drains and adjoining water bodies from sewage contamination.[29] The proposed project designs are based on flood risk concepts, defined as a function of flood hazards,

[24] PBIs will be used primarily for funding (i) smaller green infrastructure such as green roofs, rain gardens, vegetated swales, permeable pavements and pathways, tree planting, and community rain-harvesting structures; and (ii) machines and equipment for the sustainable O&M of stormwater drainage systems.

[25] ADB. 2018. *Strategy 2030: Achieving a Prosperous, Inclusive, Resilient, and Sustainable Asia and the Pacific*. Manila.

[26] ADB. 2020. *Asian Water Development Outlook 2020: Advancing Water Security Across Asia and the Pacific*. Manila.

[27] ADB. 2017. *Country Partnership Strategy: India, 2018–2022—Accelerating Inclusive Economic Transformation*. Manila.

[28] The World Bank is preparing a new program of multisector engagement with the Government of Tamil Nadu. Support for water resources will include data management improvement, investment in resilient watershed, reform to the state water resources policy, and a state water resources investment plan. The Japan International Cooperation Agency is preparing technical cooperation to develop a master plan for flood control measures in Chennai.

[29] ADB. 2018. *Report and Recommendation of the President to the Board of Directors: Proposed Multitranche Financing Facility, Technical Assistance Grant, and Administration of Grant to India for the Tamil Nadu Urban Flagship Investment Program*. Manila. The multitranche financing facility supports improving water supply in Mathoor and sewerage management in Manali, within the proposed project area.

exposure, and vulnerability, modified by the capacity to resist the damage, as supported by ADB knowledge and support technical assistance.[30] ADB technical assistance from the Urban Climate Change Resilience Trust Fund helped the state government conduct basin-wide studies of water-related disaster risks considering climate change in selected vulnerable coastal towns, including Chennai.[31] Hydrologic and climate models developed in the study were considered in the proposed project designs.

17. With ADB support, the project design includes (i) a more robust and adaptive integrated approach to cope with a wide range of climate change and disaster risks through structural and nonstructural measures, contributing to the adaptation and resilience-related goal of the Paris Agreement, and to the priorities of the Sendai Framework for Disaster Risk Reduction; (ii) green solutions such as a green infrastructure design manual, and PBIs for green infrastructure; (iii) integrated urban planning, by linking flood hazard zoning with spatial and land use planning; (iv) making future flood resilience measurable by establishing a benchmark and developing a framework to improve the city's performance in natural, economic, social, physical, and institutional dimensions; (v) a citizen-centric flood observatory system to gather local information in larger areas and complement the early flood warning system being developed by the GCC; (vi) an incentive mechanism, operation and maintenance improvement plan, and resource mobilization road map to promote sustainable O&M of stormwater drainage systems; and (vii) enhanced gender responsiveness and social inclusion to mitigate the long-term social consequences of flooding. These project interventions will help the GCC to transform the project area into a livable city. Integrated urban planning, along with climate-resilient infrastructure, will improve municipal revenues through effective land value capturing, enabling sustainable provision of quality municipal services to the citizens.

18. To further add value, a project grant from the Japan Fund for Poverty Reduction (JFPR) is being processed as cofinancing to improve the management of flood and pandemic risks in flood-prone low-income communities in the Chennai–Kosasthalaiyar basin. Chennai is among the cities in India most severely affected by the coronavirus disease (COVID-19), with more than 540,000 confirmed cases as of 15 August 2021.[32] Low-income urban communities are increasingly vulnerable to multiple crises from COVID-19 outbreaks and climate-related disasters. The JFPR grant will improve infection prevention and control of COVID-19 through interventions to enhance (i) water, sanitation, and hygiene (WASH) at schools and community health centers;[33] (ii) water quality and disease surveillance;[34] and (iii) community preparedness and response capacity to deal with the dual crises of pandemics and floods. Also, a grant from the Global Environment Facility (GEF) is being processed, which will enhance flood retention capacity in the GCC via water body rejuvenation. This involves implementing nature-based solutions in the

[30] ADB. 2018. *Technical Assistance for Strengthening Integrated Flood Risk Management*. Manila (TA 9634-REG).
[31] ADB. 2019. *Strengthening Climate Change Resilience in Urban India—Strengthening Smart Water Management and Urban Climate Change Resilience in Tamil Nadu (Subproject 1)*. Consultant's report. Manila (TA9129-IND).
[32] Government of Tamil Nadu, Health and Family Welfare Department. 2021. *Daily Report on Public Health Measures Taken for COVID-19*. Media Bulletin. 15 August.
[33] Heads of state and government and leaders of United Nations agencies, international financial institutions, civil society, private firms, and research and learning institutions issued a joint statement to prioritize water supply, sanitation, and hygiene in response to COVID-19. Sanitation and Water for All. World Leaders' Call to Action on COVID-19.
[34] Water quality surveillance will include wastewater epidemiology for waterborne diseases and COVID-19. Spot and lab testing results will provide a real-time picture of geographic and demographic trends in the local transmission of COVID-19 and other communicable diseases, generating early warning information that will allow local governments to act quickly to prevent the spread of disease. The project will ensure the access of women and girls in low-income communities to the proposed labs.

project area, restoring biodiversity and ecosystem services, and providing recreational benefits to citizens.[35]

19. **Replication and scaling up strategy.** The project's innovative designs and interventions for climate-resilient flood management along with integrated urban planning and enhanced municipal resource mobilization can be widely replicated for cities that are increasingly exposed to climate and disaster risks in India and beyond. To promote replication, ADB will capture the experience and knowledge gained from the project into knowledge products, and disseminate these to the government through workshops and regional forums, and through the Capacity Development Resource Center in ADB's India Resident Mission. The COVID-19 response being processed for JFPR cofinancing (para. 18) will be a pilot intervention of ADB COVID-19 and WASH nexus support in India, and a model of an integrated response to epidemics and disasters in urban areas across South Asia. An innovative disease surveillance and epidemic response can be applied in settings with few resources. Successful implementation will encourage scaling up of the model across the region through knowledge publications and workshops. Further, good practices and lessons on water body rejuvenation to be financed through the GEF grant being processed (para. 18) will be shared with cities in India—through a platform under the National Institute for Urban Affairs—and globally under the GEF Sustainable Cities Global Platform. The global platform will deliver technical services such as thematic training, support for innovation on urban planning, and peer-to-peer learning to more than 50 cities across 17 countries, including 33 cities in Asia. The experience and approaches of the project including the nature-based solution of water body rejuvenation will be relevant to cities around the world searching for integrated solutions to urban water resources management and flood risk mitigation.

D. Summary Cost Estimates and Financing Plan

20. The project is estimated to cost $470.5 million (Table 1). Detailed cost estimates by expenditure category and by financier are included in the project administration manual (PAM).[36]

Table 1: Summary Cost Estimates
($ million)

Item			Amount[a]
A.	**Base Cost**[b]		
	1.	Climate-resilient urban flood protection infrastructure improved in the Chennai–Kosasthalaiyar River basin	396.2
	2.	Urban flood preparedness of the Greater Chennai Corporation and project communities enhanced	8.7
	3.	Measures for sustaining operation and maintenance of stormwater drainage system established in the Greater Chennai Corporation	7.1
		Subtotal (A)	**412.0**
B.	**Contingencies**[c]		**47.9**
C.	**Financial Charges During Implementation**[d]		**10.7**
		Total (A+B+C)	**470.5**

Note: Numbers may not sum precisely because of rounding.
[a] Includes taxes and duties of $43.6 million. Such amount does not represent an excessive share of the project cost.
[b] In April 2021 prices; exchange rate of $1.0 = ₹74.8 is used.

[35] In December 2019, the GEF Council approved the concept for a national project in India that includes a demonstration nature-based solution investment in Chennai, under its global Sustainable Cities Impact Program. The global Sustainable Cities Impact Program aims to support cities in tackling their main global environmental challenges through an integrated and sustainable approach. Grant resources of $6.76 million have been set aside by the GEF Trustee to cofinance the ADB loan. The final detailed proposal for the India project under the Sustainable Cities Impact Program is being finalized for approval by the GEF.
[36] Project Administration Manual (accessible from the list of linked documents in Appendix 2).

[c] Physical contingencies are computed at 5.0% for civil works and equipment. Price contingencies are computed at 1.6%–1.8% on foreign exchange costs and 4.0% on local currency costs, and include provision for potential exchange rate fluctuation under the assumption of a purchasing power parity exchange rate.
[d] Includes interest and commitment charges. Interest during construction for the Asian Development Bank loan has been computed at the 5-year United States dollar fixed-swap rate plus a spread of 0.50% and a maturity premium of 0.10%. Commitment charges for the Asian Development Bank loan are 0.15% per year to be charged on the undisbursed loan amount.
Source: Asian Development Bank estimates.

21. The Government of India has requested a regular loan of $251 million from ADB's ordinary capital resources to help finance the project. The loan will have a 25-year term, including a grace period of 6 years; an annual interest rate determined in accordance with ADB's London interbank offered rate (LIBOR)-based lending facility; a commitment charge of 0.15% per year; and such other terms and conditions set forth in draft loan and project agreements. Based on the custom-tailored repayment method, the average maturity is 15.95 years, and the maturity premium payable to ADB is 0.10% per year.[37]

22. The summary financing plan is in Table 2. The loan will finance expenditures in relation to (i) part of the civil works and equipment, (ii) consulting services, and (iii) PBI schemes. The Government of Tamil Nadu will provide $219.5 million to cover (i) part of the civil works and equipment, (ii) taxes and duties, (iii) land acquisition and resettlement, (iv) contingencies, and (v) financing charges during implementation. The Government of Tamil Nadu has provided assurance that it will meet any financing shortfall to ensure that the project outputs are fully achieved. Climate adaptation is estimated to cost $141.6 million. ADB will finance $87.0 million in adaptation costs (61.4%) and the government will finance $54.6 million (38.6%).[38]

Table 2: Summary Financing Plan

Source	Amount ($ million)	Share of Total (%)
Asian Development Bank		
Ordinary capital resources (regular loan)	251.0	53.3
Government	219.5	46.7
Total	**470.5**	**100.0**

Source: Asian Development Bank estimates.

E. Implementation Arrangements

23. Implementation arrangements are summarized in Table 3 and described in detail in the PAM (footnote 36). The potential impact of the COVID-19 pandemic on implementation is factored into the project implementation period and corresponding cost estimates.

Table 3: Implementation Arrangements

Aspects	Arrangements
Implementation period	October 2021–June 2027
Estimated completion date	30 June 2027
Estimated loan closing date	31 December 2027
Management	

[37] Custom-tailored repayment refers to a tailored amortization structure that reflects the cash flow projections of the borrower.
[38] Climate Change Assessment (accessible from the list of inked documents in Appendix 2). The climate adaptation costs include the incremental costs of (i) enhanced storm drainage capacity to cope with 1:2-year return period rainfall and sea level rise under the RCP 8.5 scenario to 2050, (ii) the installation of catchpits with a groundwater recharge structure, (iii) the rehabilitation and capacity augmentation of primary channels, and (iv) the implementation of capacity-building and awareness campaigns.

Aspects	Arrangements		
(i) Oversight body	State-level steering committee Chief secretary (chair); additional chief secretary, MAWSD; additional chief secretary, Finance Department; principal secretary, PWD; principal secretary, HMPD; and commissioner, GCC (members)		
(ii) Executing agency	MAWSD		
(iii) Key implementing agency	GCC		
(iv) Implementation unit	PMU (GCC: 4 staff); PIU (GCC SWDD: 32 staff)		
Procurement	Open competitive bidding (nationally advertised)	46 contracts	$397.26 million
Consulting services	QCBS (loan)	728 person-months	$9.98 million
Retroactive financing and/or advance contracting	Advance contracting and retroactive financing of civil works, equipment, and consulting services will be done. Retroactive financing will be considered for up to 20% of the loan amount for eligible expenditures incurred before loan effectiveness, but not earlier than 12 months before the signing of the loan agreement.		
Disbursement	Disbursement of the loan proceeds will follow ADB's *Loan Disbursement Handbook* (2017, as amended from time to time) and detailed arrangements agreed between the government and ADB.		

ADB = Asian Development Bank, GCC = Greater Chennai Corporation, HMPD = Highways and Minor Ports Department, MAWSD = Municipal Administration and Water Supply Department, PIU = project implementation unit, PMU = project management unit, PWD = Public Works Department, QCBS = quality- and cost-based selection, SWDD = Storm Water Drain Department.
Source: Asian Development Bank.

III. DUE DILIGENCE

A. Technical

24. The project will address the major root causes of floods by constructing integrated flood management infrastructure in the Chennai–Kosasthalaiyar basin and strengthening the capacity of the GCC and communities to operate these assets. The drainage design of the proposed GCC's system ensures the integration of eight major lakes and three other surplus channels maintained by the Tamil Nadu Public Works Department in the Chennai–Kosasthalaiyar basin. The climate risk and adaptation assessment was prepared as part of the technical due diligence. The proposed stormwater drainage system features a climate-resilient design to cope with intensifying rainfall, a higher sea level rise, and a storm surge caused by a cyclone (para. 12). Catchpits will boost groundwater recharge in paved areas of a region at risk of water scarcity.

B. Economic and Financial Viability

25. **Economic analysis.** The economic rationale for government intervention is sound, as the project aims to improve basic urban services in Chennai City, focusing on flood risk management. The economic analysis for the project assesses direct and indirect damage and losses for flood events.[39] The benefits associated with the project interventions include (i) avoided flood damage costs to assets and physical infrastructure, and (ii) other avoided costs.[40] The probability distribution function of these costs is estimated based on the frequency of floods with different intensities. The net benefits are calculated as the difference between the without-project and with-project scenarios. The estimated economic internal rate of return of the project is 13.5%, which is

[39] The project will directly benefit 1.9 million people living in the flood-prone areas, and indirectly benefit 2.8 million people in the project area through an improved drainage system.
[40] Other avoided costs include savings in residential flood maintenance costs, road maintenance costs, income loss to residents during flooding days, and income loss to commercial units.

higher than the minimum required economic opportunity cost of capital of 6.0%,[41] indicating significant economic returns. Sensitivity analysis results were satisfactory, including in a scenario that combines a 20% increase in capital and O&M costs, a 20% reduction in project benefits, and an implementation delay of 1 year. The economic viability is expected to strengthen if unquantifiable benefits such as environmental improvement, industrial development, and savings in health expenditures are included in the analysis.

26. **Financial analysis.** The project does not generate revenue. There is no project-specific revenue stream that would cover O&M expenses. Historical and future cash flow analysis was conducted for the GCC, which will operate and maintain the assets to be constructed under this project. Analysis found that the GCC (i) shows an operating surplus in recent years, except fiscal year 2018; (ii) depends largely on its own income, while the Government of Tamil Nadu has provided adequate revenue grants and subsidies as needed to improve the GCC's operating revenue; (iii) has recently maintained adequate operating revenue to cover operating expenditures; and (iv) has the financial capacity for the O&M of the project, especially for the initial years of operation of the assets to be created under the loan. The financial sustainability risk is thus categorized *moderate.* The GCC is taking the initiative to increase property tax revenues by conducting streetwise enumeration using drone cameras, with a door-to-door physical survey, and developing a geographic information system-based map and database. The GCC will ensure the long-term O&M sustainability of the assets via a PBI program for zonal offices, a plan for sustainable O&M, and a revenue enhancement road map under output 3 (para. 14).[42]

C. Sustainability

27. Operational capacity will be strengthened through a PBI program for GCC zonal offices, which will establish performance indicators and incentives for achieving threshold scores. The key performance indicators include zonal offices regularly reporting on their maintenance activities and flood status, the completion of maintenance activities, and the incidence of flooding and inundation in zonal areas. The GCC will adopt the Sustainable O&M Plan of the stormwater drainage system, forecasting the O&M expenditures and committing to adequate allocation in its yearly budget. The plan will promote community participation, of women in particular, which is required for sustainable O&M. The project will also support the GCC to prepare and adopt a road map to enhance its resource mobilization by conducting situational analysis and strategic assessment. The road map will provide revenue administration reform in the short term and revenue policy reform in the medium term. The project features capacity building to improve GCC staff knowledge of integrated urban flood management and the skills that desilting and conservancy workers need to clean and maintain stormwater drainage systems.

D. Governance

28. **Financial management.** A financial management assessment of the GCC was conducted in accordance with ADB guidelines.[43] The GCC has adequate financial management capacity to (i) record the required financial transactions, (ii) provide reliable annual financial statements and audit reports, and (iii) safeguard financial assets. The assessed pre-mitigation financial management risk is *substantial* mainly because (i) accounts staff lack knowledge of ADB financial reporting and audit requirements and disbursement procedures because the GCC has not

[41] ADB. 2017. *Guidelines for the Economic Analysis of Projects*. Manila. For social sector projects, the minimum required economic opportunity cost of capital is 6%.
[42] Economic Analysis and Financial Analysis (accessible from the list of linked documents in Appendix 2).
[43] ADB. 2015. *Financial Management Technical Guidance Note: Financial Management Assessment*. Manila.

previously implemented an ADB-assisted project, (ii) no internal audit function exists, and (iii) the GCC statutory auditor may not be able to conduct any audit of the project financial statements in a timely manner. The risk will be mitigated by (i) engaging an accounts and finance expert to support the project, (ii) providing training on ADB financial reporting and audit requirements and its disbursement procedures, and (iii) including comprehensive financial information in quarterly progress reports. Moreover, the project financial statements will be audited annually by an independent auditor following auditing standards acceptable to ADB. A detailed financial management action plan is included in the PAM (footnote 36).

29. **Procurement.** All procurement of goods and works and consultant recruitment will adhere to the ADB Procurement Policy (2017, as amended from time to time) and Procurement Regulations for ADB Borrowers (2017, as amended from time to time). Value for money is achieved by consolidating packages based on market analysis of medium-sized companies in a balanced, competitive environment. Other factors considered are ease of implementation, the use of electronic government procurement to improve transparency, and the use of post-review sampling to improve procurement time. Conformance-based specification is adopted to achieve a high degree of cost certainty. With these arrangements, the GCC has achieved high project readiness, with all civil works contracts under the loan already awarded.

30. ADB's Anticorruption Policy (1998, as amended to date) was explained to and discussed with the governments of India and Tamil Nadu and the GCC. The specific policy requirements and supplementary measures are described in the PAM (footnote 36).

E. Poverty, Social, and Gender

31. **Poverty and social.** The project will reduce the vulnerability of Chennai–Kosasthalaiyar basin residents to frequent and destructive floods, which have in recent years destroyed property and livelihoods and greatly complicated day-to-day life. The project area includes 395 slums that house 11.7% of its population.[44] Many of these slums are densely populated and located alongside watercourses and low-lying areas, making the poor increasingly vulnerable to flooding. While improved flood protection infrastructure will directly benefit all residents in the project area, the socially excluded and vulnerable groups—income poor, women, older persons, children, and people with disabilities—are anticipated to benefit greatly from the project. The nonstructural measures will further reduce their vulnerability by enhancing flood preparedness to protect their lives and property.

32. **Gender.** The project is classified *effective gender mainstreaming.* Affirmative measures promoting gender equality and women's empowerment include (i) upgrading flood relief camps to make them gender-responsive and socially inclusive; (ii) enhancing community capacity, including of women, in green infrastructure investments and rainwater harvesting; (iii) conducting awareness programs targeting women on flood risks and the links that connect flooding, solid waste management, and the protection of water bodies; (iv) conducting audience-segmented behavior change communication campaigns in slums to raise awareness of the vulnerabilities of women, children, older persons, and people with disabilities in the context of flooding; (v) training vulnerable slum dwellers, especially women, to enhance their employability or alternative livelihoods; and (vi) providing staff training for institutional strengthening and gender sensitization.[45]

[44] Government of Tamil Nadu, Housing and Urban Development Department. 2016. *Tamil Nadu Slum Clearance Board Slum Survey 2015–2016.* Chennai.

[45] Gender Equality and Social Inclusion Action Plan (accessible from the list of linked documents in Appendix 2).

F. Safeguards

33. The project implementation unit will prepare semiannual environmental and social monitoring reports for ADB review and disclosure. In compliance with ADB's Safeguard Policy Statement (2009), the project's safeguard categories are as follows.[46]

34. **Environment (category B).** The GCC has prepared an initial environmental examination (IEE) report, including an environmental management plan, for the proposed improvement of stormwater drainage systems. The project is located in urban and peri-urban areas along the Bay of Bengal coast. The IEE shows that project activities are unlikely to have significant adverse environmental impacts that are unprecedented or irreversible. Predicted impacts are short term, site-specific, and experienced mainly during construction, and they can be mitigated or minimized to an acceptable level with good construction practices and the mitigation measures defined in the environmental management plan, which has a health and safety plan specific to COVID-19. No works will commence in the Coastal Regulation Zone until clearance is obtained. Meaningful stakeholder consultations were conducted during project preparation and will continue throughout implementation. The GCC will implement an institutional mechanism to manage safeguards, as detailed in the PAM (footnote 36).[47] The IEE has been disclosed on the ADB and GCC websites and updated before the contract award.

35. **Involuntary resettlement (category B).** The GCC has prepared three resettlement plans to cover all project components. No land acquisition is envisaged. Livelihood impacts are anticipated to be temporary, for a maximum of 15 days each, to 650 business owners (2,192 family members) and 23 kiosks (79 family members). Loss of minor structures, such as steps or ramps during construction, is anticipated for 1,873 property owners (7,133 family members) and will be restored by the contractor. Compensation and assistance following the entitlement matrix will be provided before displacement. The proposed mitigation measures and safeguard plans adequately address the assessed impacts. A grievance redress mechanism will be established and disclosed to beneficiaries and affected persons. Although the GCC demonstrated its capacity to meet multilateral development bank safeguard policy requirements while implementing a World Bank project, this will be its first ADB-financed project. Thus, capacity building on ADB social safeguard requirements is proposed. The GCC will establish institutional arrangements to manage and monitor social safeguards, as detailed in the PAM (footnote 36). The resettlement plans have been disclosed on the ADB and updated before the contract award. The GCC disclosed the resettlement plans on its website and in the local language to affected persons.

36. **Indigenous peoples (category C).** Scheduled tribes comprise only 0.22% of the population of Chennai. They are assimilated into urban society and do not retain such defining characteristics of scheduled tribes as distinctive culture, shyness, geographical isolation, or social and economic backwardness.[48] No direct or indirect impacts are anticipated on the dignity, human rights, livelihood systems or territories, or natural or cultural resources that are used, owned, occupied, or claimed by indigenous peoples as their ancestral domain or assets.

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[46] ADB. Safeguard Categories.

[47] The mechanism will guide the handling of environmental grievances in line with a grievance redress mechanism for the project, as well as the preparation and submission of semiannual environmental monitoring reports for ADB review and disclosure.

[48] Census of India, Directorate of Census Operations. 2011. Tamil Nadu. Series 34 Part XII-B. *District Census Handbook: Chennai*. Chennai.

G. Summary of Risk Assessment and Risk Management Plan

37. Significant risks and mitigating measures are summarized in Table 4 and described in detail in the risk assessment and risk management plan.[49]

Table 4: Summary of Risks and Mitigating Measures

Risk	Mitigation Measures
Greater Chennai Corporation lacks experience in implementing ADB-financed projects which may result in noncompliance with ADB's financial management requirements as well as delays in disbursements.	The project will (i) engage an accounts and finance expert to support the PMU and PIU, (ii) provide continuous training to the PMU and PIU accounts staff in ADB's disbursement procedures and systems as well as financial reporting and audit requirements, (iii) include comprehensive financial management information in quarterly progress reports submitted to ADB, and (iv) engage an independent auditor to audit the project financial statements annually in accordance with audit standards acceptable to ADB.

ADB = Asian Development Bank, PIU = project implementation unit, PMU = project management unit.
Source: Asian Development Bank.

IV. ASSURANCES

38. The governments of India and Tamil Nadu, and the GCC have assured ADB that implementation of the project shall conform to all applicable ADB requirements, including those concerning anticorruption measures, safeguards, gender, procurement, consulting services, financial management, and disbursement as described in detail in the PAM and loan documents. The governments of India and Tamil Nadu, and the GCC have agreed with ADB on certain covenants for the project, which are set forth in the draft loan and project agreements.

V. RECOMMENDATION

39. I am satisfied that the proposed loan would comply with the Articles of Agreement of the Asian Development Bank (ADB) and recommend that the Board approve the loan of $251,000,000 to India for the Integrated Urban Flood Management for the Chennai–Kosasthalaiyar Basin Project, from ADB's ordinary capital resources, in regular terms, with interest to be determined in accordance with ADB's London interbank offered rate (LIBOR)-based lending facility; for a term of 25 years, including a grace period of 6 years; and such other terms and conditions as are substantially in accordance with those set forth in the draft loan and project agreements presented to the Board.

Masatsugu Asakawa
President

1 September 2021

[49] Risk Assessment and Risk Management Plan (accessible from the list of linked documents in Appendix 2).

DESIGN AND MONITORING FRAMEWORK

Impacts the Project is Aligned with Chennai City made a safe place to live in, with reduced vulnerability to disaster (City Disaster Management Plan)[a]			
Results Chain	**Performance Indicators**	**Data Sources and Reporting Mechanisms**	**Risks and Critical Assumptions**
Outcome Climate and disaster resilience in the Chennai–Kosasthalaiyar River basin strengthened	By 2028: 1.9 million people living in the flood-prone areas of the Chennai–Kosasthalaiyar River basin protected from flood risk from a 1:2-year return period rainfall (2021 baseline: 0) (OPs 3.2 and 4.1)[b]	GCC reports, including rainfall data, flood area records, and flood-affected people records	A: The precipitation level and sea level rise will be within climate change projections under the RCP 8.5 scenario. R: Delay in the completion of other planned water body restoration and channel rehabilitation projects under the Public Works Department may limit full realization of expected benefits.[c]
Outputs 1. Climate-resilient urban flood protection infrastructure improved in the Chennai–Kosasthalaiyar River basin	By 2027: 1a. 588 km of new stormwater drains constructed (2021 baseline: 0) (OPs 1.3.1, 3.2.5, and 4.1.2) 1b. 175 km of stormwater drains upgraded (2021 baseline: 0) (OPs 1.3.1, 3.2.5, and 4.1.2) 1c. 11 km stretches in four primary channels (Ambattur, Korattur, Kadappakkam, and Ariyallur) rehabilitated (2021 baseline: 0) (OPs 1.3.1, 3.2.5, and 4.1.2) 1d. One stormwater pumping station of 200 kW upgraded, and one new stormwater pumping station of 200 kW commissioned (2021 baseline: 0) (OPs 1.3.1, 3.2.5, and 4.1.2) 1e. 23,000 catchpits with rainwater harvesting structures constructed (2021 baseline: 0) (OPs 1.3.1, 3.2.5, and 4.3.1) 1f. Four GCC disaster relief camps (one per project zone) rehabilitated, with gender-responsive and socially inclusive features (2021 baseline: 0) (OPs 1.3.1, 2.5.2, and 4.1.2)[d]	1a.–1f. Project quarterly progress report, GCC annual reports	R: Heavy monsoons exceeding projections may delay construction. R: Surge in prices of materials and prolonged impact of COVID-19 on movement of goods and services may result in cost overrun and delay in project completion.
2. Urban flood preparedness of the GCC and project communities enhanced	**Integrated urban planning** 2a. By 2024, guidelines for integrating flood hazard zoning with spatial plans and land use, building and development regulations endorsed by the GCC (2021 baseline: no guideline) (OPs 3.2.4 and 4.3.1) 2b. By 2025, baseline FRI and FRI framework for four river basins and the entire Chennai City established (2021 baseline: not applicable) (OP 4.2.1)	2a. and 2c. GCC council resolutions 2b. and 2d. Project quarterly progress report	R: Competing priorities and turnover of key GCC staff disrupt business continuity and delay completion of target outputs.

Results Chain	Performance Indicators	Data Sources and Reporting Mechanisms	Risks and Critical Assumptions
	2c. By 2024, manual for green infrastructure design, including rainwater harvesting, endorsed by the GCC (2021 baseline: not applicable) **Citizen's engagement and awareness** 2d. By 2025, FCO for Chennai City operationalized (2021 baseline: not applicable) (OP 6.2.4) 2e. By 2025, at least 200 persons (including at least 50% women) in project community reported increased knowledge on green infrastructure schemes, including rainwater harvesting; flood risks and impacts; and the links between flooding, solid waste management, sewerage service house connections, and the protection of water bodies (2021 baseline: not applicable) (OPs 2.5 and 4.3.2) **Institutional capacity building and knowledge dissemination** 2f. By 2025, at least 50% of GCC technical staff (Storm Water Drain Department) in the project area, including 80% of women technical staff, reported increased knowledge on planning and design for stormwater drainage systems and management of solid waste and flood risks (2021 baseline: 0) (OPs 2.2, 4.3.2, and 6.1.1) 2g. By 2026, at least two knowledge products on good practices and lessons on integrated urban flood management published and presented to at least 100 key government officials and sector experts, of whom at least 80 participants reported increased knowledge (2021 baseline: 0)	2e.–2g. Pre- and post-training survey and assessment	
3. Measures for sustaining O&M of stormwater drainage system established in the GCC	3a. By 2023, a key performance indicator-based stormwater drainage operation performance improvement system established in 12 out of 15 zonal offices of the GCC (2021 baseline: not applicable) (OP 6.2.1) 3b. By 2025, Sustainable Operation and Maintenance Improvement Plan of stormwater drainage system with gender-responsive and socially inclusive features approved by the GCC (2021 baseline: not applicable) (OPs 3.2.2 and 4.3.1)[e] 3c. By 2024, road map for municipal resource mobilization approved by the GCC (2021 baseline: 0) (OP 4.2.2) 3d. By 2025, at least 50% of GCC technical staff (Storm Water Drain Department) in the project area, including 80% of women technical staff, reported increased knowledge on sustainable O&M of stormwater drainage systems and management of solid waste and flood risks (2021 baseline: 0) (OPs 2.2, 4.3.2, and 6.1.1)	3a.–3c. GCC annual report, GCC budget 3d.–3e. Pre- and post-training survey and assessment	R: Change in leadership may affect momentum on reform program.

Results Chain	Performance Indicators	Data Sources and Reporting Mechanisms	Risks and Critical Assumptions
	3e. By 2025, 100 drain desilting workers and conservancy workers (including at least 50 women workers) reported increased knowledge and skills of cleaning and maintaining stormwater drainage systems (2021 baseline: 0) (OP 2.2)		

Key Activities with Milestones

1. Climate-resilient urban flood protection infrastructure improved in the Chennai–Kosasthalaiyar River basin

1.1 Award all works contracts by June 2021
1.2 Complete all civil works by June 2027

2. Urban flood preparedness of the GCC and project communities enhanced

2.1 Draft guidelines for integrating flood hazard zoning with spatial plans and land use, building and development regulations by June 2023
2.2 Develop FRI for four basins and Chennai City by December 2022
2.3 Draft and adopt FRI framework for four basins and Chennai City by December 2024
2.4 Draft green infrastructure design manual by December 2023
2.5 Draft concept paper and detailed feasibility report for FCO by December 2023
2.6 Prepare and adopt FCO by December 2024
2.7 Conduct knowledge-building workshops on green infrastructure, including rainwater harvesting, by June 2025
2.8 Conduct six awareness workshops on flood risks and impacts and the links between flooding, solid waste management, sewerage house service connections, and the protection of water bodies by June 2024
2.9 Conduct knowledge-building workshops on the planning and design of urban drainage systems by June 2025
2.10 Prepare knowledge products on the good practices and lessons of the project, and conduct a dissemination workshop by July 2026

3. Measures for sustaining O&M of stormwater drainage system established in the GCC

3.1 Prepare and adopt baseline key performance indicators by December 2022
3.2 Prepare an inclusive sustainable O&M improvement plan by December 2024
3.3 Draft a road map for municipal resource mobilization by December 2023
3.4 Conduct knowledge-building workshops on sustainable operation and management of urban drainage systems by June 2025
3.5 Conduct training on cleaning and maintaining stormwater drainage systems for drain desilting workers and conservancy workers by June 2025

Project Management Activities

Mobilize project support consultant by July 2021
Mobilize institutional strengthening and reforms consultant by November 2021
Implement gender equality and social inclusion action plan from July 2021 to June 2027
Review missions, midterm review, and preparation of progress and annual reports

Inputs

Asian Development Bank: $251.0 million (regular ordinary capital resources loan)
Government: $219.5 million

A = assumption, COVID-19 = coronavirus disease, FCO = flood citizen observatory, FRI = flood resilience index, GCC = Greater Chennai Corporation, km = kilometer, kW = kilowatt, O&M = operation and maintenance, OP = operational priority, R = risk, RCP = Representative Concentration Pathway.

[a] Greater Chennai Corporation. 2017. *City Disaster Management Plan*. Chennai.

[b] A 1:2-year return period rainfall corresponds to rainfall intensity of 68 mm per hour. People protected from flood risk is the number of people not subjected to any kind of inundation on days when the rainfall intensity published by India Meteorological Department's Redhills rain gauging station is less than 68 mm per hour. It is calculated by deducting the population of reported inundation areas within the project area as per GCC records from the total population of the project area. The minimum number from such daily calculations in a year is reported as the project outcome.

[c] Other planned projects include (i) water body restoration in Ambattur lake, Korattur lake, Retteri lake, Sadayankuppam lake, Ariyalur lake, Kadapakkam lake, Madhavaram Periyathoppu lake, and Kolathur lake; and (ii) channel rehabilitation in Ratteri South channel, Ratteri North channel, and Puzhal channel.

[d] A gender-responsive and socially inclusive relief camp will have the following features: (i) at least one female worker or caretaker with supplies of sanitary napkins, soap, and a basic first aid kit with medicines; (ii) safe spaces (affording privacy and security) for women, especially nursing mothers and adolescent girls; (iii) well-lit and clean toilets for men and women, with barrier-free access for people with disabilities and older persons; water, hooks, ledges, and shelves in the toilet; and provisions for washing and disposal of menstrual products; (iv) regular (daily) visits by female student volunteers and awareness generation on women's vulnerability to violence and trafficking; (v) regular

interaction between volunteers and people with disabilities within the relief camp; and (vi) helpline numbers displayed on walls.

[e] The Sustainable Operation and Maintenance Improvement Plan identifies the institutional, technical, financial, and social requirements to ensure the sustainable operation and maintenance of the stormwater drainage system. It will include community responsibility and participation, including women's participation.

Contribution to Strategy 2030 Operational Priorities

Expected values and methodological details for all OP indicators to which this operation will contribute results are detailed in Contribution to Strategy 2030 Operational Priorities (accessible from the list of linked documents in Appendix 2).

Source: Asian Development Bank.

LIST OF LINKED DOCUMENTS

http://www.adb.org/Documents/RRPs/?id=49107-009-3

1. Loan Agreement
2. Project Agreement
3. Sector Assessment (Summary): Water and Other Urban Infrastructure and Services (Urban Flood Protection)
4. Project Administration Manual
5. Financial Analysis
6. Economic Analysis
7. Summary Poverty Reduction and Social Strategy
8. Risk Assessment and Risk Management Plan
9. Contribution to Strategy 2030 Operational Priorities
10. Climate Change Assessment
11. Gender Equality and Social Inclusion Action Plan
12. Initial Environmental Examination
13. Resettlement Plan: Civil Works Package Numbers 01–11 (Phase 1)
14. Resettlement Plan: Civil Works Package Numbers 12–15 and 33–46 (Phase 2)
15. Resettlement Plan: Civil Works Package Numbers 16–32 (Phase 3)