# Initial Environmental Examination

Document Stage: Draft for Consultation
Project Number: 49107-009
June 2021

# INDIA: Integrated Urban Flood Management for the Chennai - Kosasthalaiyar Basin Project – PART A

Prepared by Greater Chennai Corporation (GCC) for the Asian Development Bank.

## CURRENCY EQUIVALENTS

(as of 2 June 2021)

| | | |
|---|---|---|
| Currency Unit | – | Indian rupee (₹) |
| ₹1.00 | – | $0.0137 |
| $1.00 | = | ₹72.854 |

## ABBREVIATIONS

| | | |
|---|---|---|
| ADB | – | Asian Development Bank |
| AAQ | – | Ambient Air Quality |
| CGWB | – | Central Groundwater Board |
| CMA | – | Chennai Metropolitan Area |
| CRZ | – | Coastal Regulation Zone |
| CMRL | – | Chennai Metro Rail Limited |
| CPCB | – | Central Pollution Control Board |
| CRO | – | Complaint Receiving Officer |
| DPR | – | Detailed Project Report |
| EA | – | Executing Agency |
| EAC | – | Expert Appraisal Committee |
| EC | – | Environmental Clearance |
| EHS | – | Environmental Health and Safety |
| EIA | – | Environmental Impact Assessment |
| EMP | – | Environmental Management Plan; |
| EMR | – | Environmental Monitoring Report |
| ES | – | Environmental Specialist |
| ESS | – | Environmental and Social Safeguards |
| GoI | – | Government of India |
| GoTN | – | Government of Tamil Nadu |
| GCC | – | Greater Chennai Corporation |
| GRM | – | Grievance Redress Mechanism |
| IA | – | Implementing Agency |
| IBAT | – | Integrated Biodiversity Assessment Tool |
| IEE | – | Initial Environmental Examination; |
| IUFMCKB | – | Integrated Urban Flood Management for the Chennai-Kosasthalaiyar Basin |
| IUCN | – | International Union for Conservation of Nature |
| LPM | – | Liters Per Minute |
| MLD | – | Million liters per day |
| MAWS | – | The Municipal Administration and Water Supply Department |
| MFF | – | Multi-Tranche Financing Facility |
| MRTS | – | Mass Rapid Transit System |
| MOEF&CC | – | Ministry of Environment, Forest and Climate Change |
| NOC | – | No Objection Certificate |
| NH | – | National Highways |
| NGO | – | Non-Governmental Organization |
| NAAQ | – | National Ambient Air Quality |
| O&M | – | Operation and Maintenance |
| PIU | – | Project Implementation Unit; |
| PSC | | Project Support Consultants |
| PWD | – | Public Works Department |
| PMU | – | Project Management Unit |

| | | |
|---|---|---|
| PPTA | – | Project Preparatory Technical Assistance |
| RCC | – | Reinforced Cement Concrete |
| REA | – | Rapid Environmental Assessment Checklist |
| SEIAA | – | State Environmental Impact Assessment Authority |
| SEMP | – | Site-Specific Environmental Management Plan |
| SO | – | Safeguards Officer |
| SOP | – | Standard Operating Procedures |
| SEMP | – | Site environmental management plan |
| SPS | – | Safeguard Policy Statement, 2009 |
| STP | – | Sewage Treatment Plant |
| SWPS | – | Storm Water Pumping Station |
| TMP | – | Traffic Management Plan |
| TNPCB | – | Tamil Nadu Pollution Control Board |
| TNSCZMA | – | Tamil Nadu State Coastal Zone Management Authority |
| WHO | – | World Health Organization |
| WTP | – | Water Treatment Plant |

## WEIGHTS AND MEASURES

| | | |
|---|---|---|
| °C | – | Degree Celsius |
| km | – | kilometre |
| LPCD | – | litres per capita per day |
| m | – | metre |
| MLD | – | million litres per day |
| mm | – | millimetre |
| $km^2$ | – | square kilometer |

## NOTE

In this report, "$" refers to United States dollar.

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## EXECUTIVE SUMMARY

Chennai, located on the coromandel coast of the Bay of Bengal, and is the fourth-largest metropolitan area in India, with an estimated population of 10.7 million. Watershed area in Chennai has been divided into 4 major water basins (i) Kosasthalaiyar, (ii) Cooum, (iii) Adyar, and (iv) Kovalam. Greater Chennai Corporation (GCC) together with the state Public Works Department (PWD) are the responsible departments/ organizations in maintaining the infrastructure for the disposal of the storm water in GCC area, spread over 426 $km^2$. The floods that occurred in the past were severe along the waterways of Adyar, Cooum, Kosasthalayar Rivers, Buckingham Canal and also along the Pallikaranai Marshland. Chennai region has also been battered by incessant heavy rainfall during the year 2015 causing water stagnation and inundation. To address the issues relating to water stagnation and inundation, as a first step, the GCC has initiated the improvement of storm water drainage system in Adyar and Cooum basins with financial support from the World Bank, the project is in the verge of completion. A similar project for the Kovalam basin is contemplated with financial support from the KfW. For the Kosasthalaiyar basin, GCC proposed the “Integrated Urban Flood Management for the Chennai-Kosasthalaiyar Basin (IUFMCKB) Project” for implementation, with the financial assistance of Asian Development Bank (ADB).

**The Project.** Kosasthalaiyar River Basin is located in the northern part of Chennai consisting of an area of 127.80 $km^2$ covering GCC administrative zones 1, 2, 3, and 7 (fully covered) and 6 and 8 (partially covered). The project area has been divided into eleven (11) watersheds based on the topography and natural flow patterns. The total length of the existing storm water drain is 280 km, of which 105 km length of drain is in good condition which will be retained. The remaining 175 km of drain is required to be rehabilitated due to inadequate hydraulic carrying capacity. Apart from the existing drain (280 km), new drain for a length of 588 km have been proposed. Necessary interlinking of water bodies through the existing or proposed drain has also been considered to maintain the water balance and achieve maximum water storage within the Kosasthalaiyar drainage basin. In addition, improvements to four out of seven macro drains/surplus canals of total length 11 km in the project area, which are managed by the Public Works Department (PWD) are also included in the ADB funded project for improvement. Improvement of remaining 3 macro drains / surplus canals of total length 18 km will be implemented PWD, for which DPR has already been prepared. The size of storm water drains range from a minimum of 600 mm (wide) x 750 (deep) mm to maximum of 7,000 mm x 2500 mm. Concrete rectangular drains with a cover slab have been proposed.

In the project area (Kosasthalaiyar drainage basin), the eastern portion of the north Buckingham-Canal watershed is lower than the canal bed level, hence an existing pumping station equipped with 2 nos. of 10 HP pumps having a capacity of 2833 LPM each and 3m diameter sump was constructed near Kargil Nagar to pump the rainwater into Buckingham Canal during floods. Based on the detailed analysis, it was found that existing pumps are very old and does not have sufficient capacity to pump the rainwater during floods. Hence, an additional pumping station comprising of 3no’s higher capacity pumps are proposed in Kargil Nagar. Based on the detailed analysis, a new storm water pumping station has been proposed at Ernavoor to avoid flood inundation.

**Project implementation arrangements**. The Municipal Administration and Water Supply Department (MAWS) of GOTN is the state-level executing agency. Greater Chennai Corporation (GCC) is the implementing Agency (IA) for this project. A Project Management Unit (PMU) has been established in GCC headed by Commissioner, GCC as a Project Director (PD) and comprising of dedicated full-time staff from GCC for the overall project and financial management. A Project Implementation Unit (PIU) has been established in the storm water drainage department

of GCC which will be headed by Project Managers (Chief Engineer and Superintending Engineer) and comprising of dedicated full-time staff of the GCC for the day-to-day implementation of the project. An Executive Engineer in PIU shall be the nodal person for safeguards implementation who will be supported by a dedicated Environmental Officer to ensure compliance with EMP. The PIU will be supported by Project Support Consultant (PSC). Environmental Expert of the PSC will assist PIU (Environmental Officer) in the implementation of the project in compliance with EMP and will carry out all necessary tasks.

**Screening and assessment of potential impacts**. ADB requires the consideration of environmental issues in all aspects of the Bank's operations, and the requirements for environmental assessment as described in ADB's Safeguard Policy Statement (SPS), 2009. As per the GoI EIA Notification, 2006, this project does not require EIA study or environmental clearance. Project area is along the coromandel coast of the Bay of Bengal, and some components fall within the Coastal Regulation Zone. Project therefore requires clearance / no objection certificate from TNSCZMA. GCC already submitted application to TNSCZMA and is currently under process. Works falling under CRZ are confined to 11 of total 46 contract packages under the project. No works will be initiated in CRZ packages until the clearance/no objection is obtained from TNSCZMA.

**Categorization.** The potential environmental impacts of the project have been assessed using ADB Rapid Environmental Assessment (REA) Checklist for Urban Development. The proposed project is not likely to have any significant adverse environmental impacts that are irreversible, diverse, or unprecedented. Potential impacts are mostly site-specific and in most cases mitigation measures can be designed with uncomplicated measures commonly used at construction sites and known to civil works contractors. Based on the assessment and ADB Safeguard Policy Statement (SPS), the project is classified as Environmental Category "B" and mandated an Initial Environmental Examination (IEE).

**Description of the Environment.** The Kosasthalaiyar River Basin covers an area of 127.80 $km^2$ and located in the northern part of GCC. The topography is characterized by flat terrain and is found sloping gently from west to east direction. In the project area, the summer season starts in the month of May with maximum temperatures around 38°C to 42°C and winter season starts in January, with maximum temperatures around 18°C to 20°C. The project area gets most of its seasonal rainfall from the north-east monsoon, which starts from mid-September to mid-December. The most prevailing winds in the project area is the South westerly, between the end of May to end of September and the North easterly during the rest of the year. The average annual rainfall is about 1,400 mm. The project area has different types of land use patterns that affects the runoff. The most predominant land-use pattern is residential (41.62 $km^2$), which is followed by commercial cum residential (20.61 $km^2$), Industrial (19.52 $km^2$), water bodies (13.71 $km^2$) and CRZ area (3.19 $km^2$). In the central and eastern portion of the project area, calcareous gritty sandstone and clay are present, alluvium in the predominant formation is found along the Kosasthalaiyar river course. The project area is free of forest areas; there are no eco-sensitive areas located within or near the project area for a radius of 10 km.[1] Pulicat Lake (located at an aerial distance of 21 km) and the Guindy National Park (10 km) are the nearest protected areas located within 50 km of project area. Project area drains into Ennore creek on the coromandel coast of the Bay of Bengal. Ennore Creek was once a biodiversity hotspot and now highly degraded due to various human activities. As per Census 2011, the population in the project area

[1] As per the MoEF&CC, 10km radius is chosen as a study area for the infrastructure projects undergoing environmental clearance.

is 25,79,645. The project area is well connected by NH 5 (Chennai-Kolkata Highway), NH 718 (Tirupathi Highway), SH 56 (Thiruvottiyur-Ponneri), Outer Ring Road and Chennai bypass road.

**Potential environmental impacts and mitigation measures**. Potential negative impacts were identified especially those concerning pre-construction, construction and operation phases. Planning principles and design considerations have been reviewed and incorporated into the site planning and design process wherever possible; thus, environmental impacts as being due to the project design or location were not significant. The project is unlikely to cause significant adverse impacts that are irreversible, diverse or unprecedented because: (i) the components will involve construction works with minimal impacts and it is very much localized. (ii) project area is mostly urban and peri urban nature, although due to its coastal location careful attention needs to be paid to minimizing disruption to coastal ecosystem; and (iii) predicted impacts are site-specific and likely to be associated with the construction process and are produced because the process is invasive, involving excavation, desilting and earth movements.

This project will positively contribute to improve the situation along the coast and Ennore creek that receives storm water / runoff from the project area. The project will improve quality of water flowing into the creek. Besides desilting of canals and drains and providing proper storm water drainage system, the proposed project design also considers minimizing the silt and sewage flow in the system. Water quality of Kosathaliayar River, Surplus channels, Buckingham and Ennore creek will be tested pre, during and post construction and operation phase to monitor the changes in water quality as per the baseline condition.

Potential impacts during construction are considered significant but temporary and there are well-developed methods to mitigate the same. Various measures are suggested to avoid sediment and contaminated flow into the coastal water during the construction. Moreover, works in the CRZ area will be initiated only after obtaining due permission from TNSCZMA. Storm water drain works will be constructed along public roads in an urban area congested with settlements, people activities and traffic. Therefore, these works will have significant impacts arising mainly from the disturbance of residents, commercial establishments and traffic due to construction work; safety risk to workers, public and nearby buildings due to trench excavations in the road, especially in narrow roads; access impediment to houses and business, disposal of large quantities of construction waste, etc. These are all general impacts of construction in urban areas, and there are well-developed methods of mitigation that are suggested in the Environmental Management Plan (EMP).

The proposed construction activities likely to generate 2 million cubic meters of surplus earth, which shall be recycled to the maximum, the remaining surplus earth will be disposed/ dumped in the Kodungaiyur dumping yard, which is owned and maintained by GCC. Project is also estimated to generate nearly 150,000 m3 of sediment/desilted material from the storm water drains and surplus canals. Sediment quality analysis indicate that material is not hazardous and will be disposed at the solid waste dumping sites owned by GCC. During the construction, confirmatory tests will be conducted, and the reuse of dried and non-hazardous silt/sediment for beneficial purposes will be explored and implemented, and the surplus will be disposed off at the solid waste facilities.

**Environmental Management Plan (EMP).** This draft IEE includes an Environmental Management Plan (EMP) which describes and addresses the potential impacts and risks identified in the environmental assessment. The EMP includes proposed mitigation measures, environmental monitoring and reporting requirements, capacity development and training

measures, implementation schedule, cost estimates, and performance indicators. This draft IEE and the corresponding EMP will be included in the bidding and contract documents with specific provisions requiring Contractors to (i) comply with all other conditions required by ADB; and (ii) to submit a site-specific environmental management plan (SEMP), including (a) proposed sites/locations for construction work camps, storage areas, hauling roads, laydown areas, disposal areas for solid and hazardous wastes; (b) specific mitigation measures following the approved EMP; (c) monitoring program as per SEMP; and (d) budget for SEMP implementation. A copy of the EMP and approved SEMP will be kept on-site during the construction period at all times.

The budget for EMP implementation includes costs for compensatory tree plantation, monitoring of ambient air quality, noise level measurements, water quality and sediment/silt quality. For compensatory tree plantation (planting of 3040 trees for the loss of 304 trees in the 1:10 ratio (as per the general directions of the High Court, Chennai)), it was decided to remit the budget to the Park Department (a wing in the GCC), who will plant and maintain the trees in the spaces available in the Public Parks (maintained by the GCC), which shall be monitored and recorded by the PSC and the PIU. Tree transplantation option shall be explored to minimize the loss of trees. The observations shall be included in the SEMR, which will be submitted to the ADB. The implementation costs of mitigation measures are covered separately under a civil work contract. Each contractor shall have an Environmental Safeguards Officer to support the contractors responsible for implementing the applicable mitigation measures given in EMP. Environmental Expert in PSC and Executive Engineer acting as nodal person for ESS in PIU are responsible for monitoring the EMP implementation.

**Consultation, disclosure and grievance redress mechanism.** The stakeholders were involved during the environmental assessment activities through discussions conducted on-site and by public consultations. The views expressed by stakeholders were incorporated in the IEE and project design. This draft IEE will be made available to the public through the ADB and GCC websites. The consultation process will continue during project implementation to ensure that stakeholders are fully engaged in the project and have the opportunity to participate in its development and implementation. A Grievance Redress Mechanism (GRM) is described within this draft IEE to ensure that public grievances are addressed quickly.

**Monitoring and Reporting.** Contractors has to submit a monthly EMP implementation report to PIU. PIU, with the assistance of PSC, will monitor the compliance of the Contractor, prepare a Quarterly Progress Report (QPR) and Semi-annual Environmental Monitoring Report (SEMR) and submit to ADB. The status of environmental safeguards implementation, issues, and corrective actions are to be clearly reported to ADB in these reports. The PMU will oversee and ensure the implementation and compliance. ADB will post the SEMR on its website.

**Conclusions and Recommendations.** As per ADB SPS 2009, this project is classified as environmental category B and does not require further Environmental Impact Assessment. This IEE is prepared based on the Detailed Project Report (DPR). However, during implementation this IEE shall be updated by PSC in discussion with PIU to reflect any changes, amendments and will be reviewed and approved by PIU. This draft IEE shall be part of tender documents. The final IEE report will incorporate results of any changes and additional baseline monitoring as required (e.g., air, noise, surface water quality) and will be submitted to ADB for approval.

# I. INTRODUCTION

## A. Background

1. Chennai, capital city of southern Indian state of Tamil Nadu, is located the coromandel coast of the Bay of Bengal and is the fourth-largest metropolitan area in India, with an estimated population of 10.7 million. It is one of India's fastest-growing major cities, with well diversified economy growing at about 6% annually. Chennai is the largest exporting hub in India, and located in the East Coast Economic Corridor, the city is a key player in the state and national economies. Chennai is a concentration of people, business and industries, infrastructure, and public institutions with a population density of about 26,000 persons per square kilometer ($km^2$). Watershed area in Chennai has been divided into 4 major water basins namely, (i) Kosasthalaiyar, (ii) Cooum, (iii) Adyar, and (iv) Kovalam. Greater Chennai Corporation (GCC) together with the state Public Works Department (PWD) are the responsible departments/ organizations in maintaining the infrastructure for the disposal of the storm water in GCC area, spread over 426 $km^2$. The floods that occurred in the past were severe along the waterways of Adyar, Cooum, Kosasthalayar Rivers, Buckingham Canal and also along the Pallikaranai Marshland. Chennai region has also been battered by incessant heavy rainfall during the year 2015 causing water stagnation and inundation. To address the issues relating to water stagnation and inundation, as a first step, the GCC has initiated the improvement of storm water drainage system in Adyar and Cooum basins with financial support from the World Bank, the project is in the verge of completion. A similar project for the Kovalam basin is contemplated with financial support from the KfW. For the Kosasthalaiyar basin, GCC proposed the "Integrated Urban Flood Management for the Chennai-Kosasthalaiyar Basin (IUFMCKB) Project" for implementation, with the financial assistance of Asian Development Bank (ADB).

2. The anticipated outcome of the proposed ADB funded IUMFCKB Project is "climate and disaster resilience in the Chennai-Kosasthalaiyar river basin strengthened" and the proposed outputs are:

(i) **Output 1**: Climate-resilient urban flood protection infrastructure improved in the Chennai–Kosasthalaiyar river basin. This will include structural measures such as: (i) construction of 588 kilometers (km) of new storm water drains; (ii) rehabilitation or replacement of 175 km of storm water drains; (iii) improvements of 11 km stretches in the Ambattur, Ariyallur, Kadappakkam, and Korattur channels to enhance water-carrying capacity; (iv) construction of one new water-pumping station and the upgrading of one existing pumping station; (v) construction of 23,000 catchpits at regular intervals in roadside drains to recharge the groundwater aquifer; and (v) rehabilitation of four disaster relief camps to be gender-responsive and socially inclusive. The proposed storm water drainage system features climate-resilient design to cope with intensifying rainfall and higher sea level rise. Infiltration pits will boost groundwater recharge in paved areas of a region at risk of water scarcity.

(ii) **Output 2**: Urban flood preparedness and pandemic resilience of the GCC 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 in the whole of 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; (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 waterbodies, including activities specifically targeting women; (vii) improved GCC staff capacity to plan and design storm water drainage systems in coordination with the management of solid waste and flood risk; and (viii) the establishment of integrated flood and pandemic risk management systems in flood-prone urban low-income communities through Japan Fund for Poverty Reduction (JFPR) Grant: (a) gender-responsive Water, Sanitation and Hygiene (WASH) and Infection Prevention and Control (IPC) measures and practices for 65 schools and 17 community health centers, (b) an inclusive surveillance system with eight mobile diagnostic labs for COVID-19 and other communicable diseases and four mobile water quality testing labs for IPC, and (c) gender-responsive and integrated community response plans for epidemics and flood disasters.

(iii) **Output 3**: **Measures for sustaining operation and maintenance of storm water drainage system established in GCC**. This will include: (i) performance-based incentives (PBIs) for zonal offices linked to operational efficiency and the sustainability of storm water drainage systems; (ii) a plan formulated to improve the sustainable and inclusive O&M of storm water drainage systems; (iii) a road map for enhancing municipal resource mobilization by the GCC; (iv) improved knowledge of GCC staff on the sustainable O&M of drainage systems with the management of solid waste and flood risk; and (v) improved knowledge and skills of desilting and conservancy workers on cleaning and maintaining storm water drainage 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 the focus on improving GCC management of drainage systems with timely maintenance services. The incentive payments will be used for additional activities supportive of the project's objective. The Sustainable Operation and Maintenance Improvement Plan will enable the GCC to ensure proper O&M of the created assets during the life of the project, based on the newly established asset management system and the experiences of PBI program. The Road Map for Enhanced Municipal Resource Mobilization will provide a strategic implementation plan to improve revenue management in its revenue coverage, valuation, liability, collection, and taxpayer services; strengthen information interlinkage with other utilities; and promote digital transformation with enhanced data analytics.

## 1. Purpose of this IEE Report

3. ADB requires the consideration of environmental issues in all aspects of the bank's operations, and the requirements for environmental assessment as described in ADB's Safeguard Policy Statement (SPS), 2009. The potential environmental impacts of the subproject have been assessed using Rapid Environmental Assessment (REA) Checklist for Urban Development (refer **Appendix 1**). The potential negative impacts were then identified in relation to pre-construction, construction and operation phases of the proposed storm water drainage project and the results of assessment shows that the subproject is unlikely to cause significant adverse impacts that are irreversible, diverse or unprecedented. Thus, this Initial Environmental Examination (IEE) has been prepared in accordance with ADB SPS's requirements for environment category 'B' project. This IEE is based on the Detailed Project Report (DPR) prepared by GCC through an external DPR consultant.

4. The IEE report is based mainly on field reconnaissance surveys and secondary sources of information. Field sample surveys conducted for silt, surface water quality, and groundwater quality. For all the relevant ambient parameters, a suitable environmental monitoring program has been developed as part of the Environmental Management Plan (EMP), which will require the Contractor to establish the baseline environmental conditions prior to commencement of civil works. The results will be reported as part of the environmental monitoring report and will be the basis to ensure no degradation will happen during project implementation. Stakeholder consultation was an integral part of the IEE and will continue throughout the project implementation.

## B. Report Structure

5. This Report contains the following elevan (11) sections including the executive summary at the beginning of the report:

(i) Executive summary
(ii) Introduction
(iii) Description of the project
(iv) Analysis of alternatives
(v) Policy, legal and administrative framework
(vi) Description of the environment
(vii) Anticipated environmental impacts and mitigation measures
(viii) Public consultation and information disclosure
(ix) Grievance redress mechanism
(x) Environmental management plan, and
(xi) Conclusion and recommendation.

# II. DESCRIPTION OF THE PROJECT

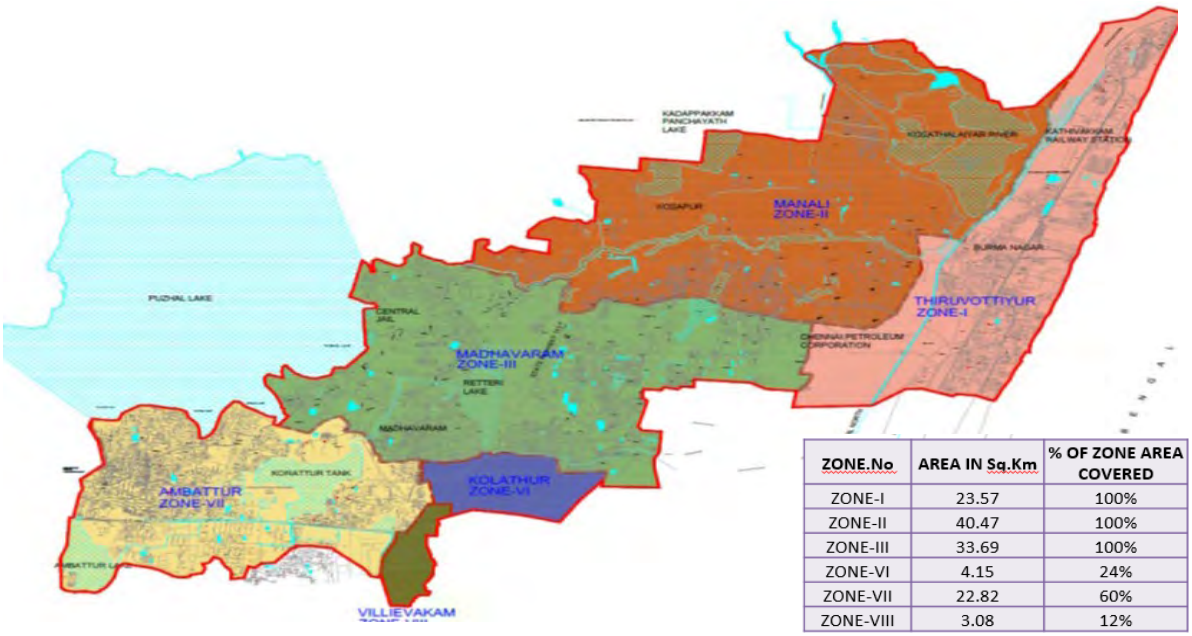
## A. Project Area

6. Kosasthalaiyar River is a west to east flowing river, and it is one of the three rivers that flow through Chennai metropolitan area. This river originates near Kaveripakkam Lake, which is an irrigation tank fed by Palar Anicut in Vellore District. The river flows in northeast direction and confluences with Bay of Bengal via Ennore Creek. Kosasthalaiyar River basin extends to an area of 3,757 km$^2$ in the northern most districts of Vellore, North Arcot, Thiruvallur and Chennai in Tamil Nadu and Chittor district of neighboring Andhra Pradesh. The catchment area in North Arcot District has a branch near Kesavaram Anicut, flows through Chennai city as Cooum River and the main Kosasthalaiyar River flows to the Poondi reservoir. Its northern tributary, Nagari River, originates in Chittoor district of Andhra Pradesh and joins the main river in the backwaters of Poondi reservoir. From the Poondi reservoir, the river flows through Thiruvallur District, enters the Chennai metropolitan area, and joins the sea at Ennore creek.

7. The part of the Kosathalaiyar river basin that is located within the greater Chennai area is called as Chennai-Kosathalaiyar basin, which is the project area of the proposed IUFMCKB Project. Figure 1 shows the Kosathalaiyar river basin and the project area, and Figure 2 shows the project areas with GCC zones. The project area is the extended area of Chennai, that is formed part of Greater Chennai Corporation in 2011. Project area is located towards northern part of Chennai consisting an area of 127.80 km$^2$ (30% of GCC area) covering following GCC administrative zones: Zone I (Thiruvottiyur, 23.57 km$^2$), Zone II (Manali, 40.47 km$^2$), Zone III (Madhavaram, 33.69 km$^2$), Zone VI (Thiru vi ka nagar, partly, 4.15 km$^2$), Zone VII (Ambattur. Partly, 22.82 km$^2$) and Zone VIII (Anna Nagar, partly, 3.1 km$^2$).

**Figure 1: Kosasthalaiyar river basin and project area**

**Figure 2: Location and GCC zones in the project area**




| ZONE.No | AREA IN Sq.Km | % OF ZONE AREA COVERED |
|---|---|---|
| ZONE-I | 23.57 | 100% |
| ZONE-II | 40.47 | 100% |
| ZONE-III | 33.69 | 100% |
| ZONE-VI | 4.15 | 24% |
| ZONE-VII | 22.82 | 60% |
| ZONE-VIII | 3.08 | 12% |

## B. Existing Storm Water Drainage Facilities

8. The storm water drainage system in project area comprises of about 280 km of storm water drains, that include roadside collector drains and main drains that convey the storm water into canals and water bodies, and ultimately into the Bay of Bengal. There are a number of lakes in the project area, such as North Ambattur Lake, Korattur Lake, Puzhal Lake, Retteri Lake, etc., and canals (Buckingham canal and lake surplus channels that carry overflow/surplus downstream) that form part of overall storm water / flood management system. Drains currently are connected to following water bodies at various locations: Puzhal lake, Retteri Lake, Madhavaram Periyathopu, Puzhal surplus, Kosasthalaiyar river, Buckingham Canal, Ennore Creek and the Bay of Bengal. Lakes are connected with surplus channels, that carry surplus overflow downstream and discharge into a lake or canal or ultimately into Bay of Bengal. Storm water that is collected from the project areas ultimately reaches the Bay of Bengal.

9. Some of the localities in the project area, especially near Buckingham canal are, low lying, and therefore pumping facilities are established in areas such as Kargil Nagar and Eranvoor to pump the accumulated storm water into Buckingham canal. Buckingham canal discharges into Ennore creek that is connected to the Bay of Bengal. In this project, the surplus canals connecting (Ambattur Lake, Korattur Lake, Kadapakkam Lake and Ariyalur Lake) have been considered for renovation/ restoration. The details of existing drains in the project area are given in the following:

10. **Table 1**. Entire storm water drainage system is managed by GCC, except the canals that fall under the jurisdiction of Public Works Department (PWD) of the Government of Tamil Nadu.

**Table 1: Existing Drain Details in Project Area**

| Description | Length (km) |
|---|---|
| Total length of road network in the ULB | 1315 |
| Total length of the existing drains | 280 |
| Existing Length of the drains in good condition | 105 |
| Existing Length of the drains to be rehabilitated | 175 |

## C. Existing Sewerage and Solid Waste Management

11. Of the total 127.80 $km^2$ of project area of Chennai-Kosasthaiyar Basin, nearly 76% (96.78 $km^2$) of the area is covered with the sewerage system. Sewerage system is already proposed for the remaining area. Detailed project report (DPR) has been prepared for 12.14 $km^2$ and is ready for execution, while DPR is under preparation for an area of 18.88 $km^2$. There are 3 sewage treatment plants of total capacity 250 MLD in operation, and another 31 MLD STP is under construction. Chennai Metro Water Supply and Sewerage Board (CMWSSB) is continuously expanding the treatment capacity to meet its demand. Except part of Manali area (Edayanchavadi, Sadayankuppam and Kadapakkam), the remaining areas will be covered by sewerage schemes. Even left out areas of Manali will also be included in the UGSS proposals in the year 2021. Due to lack of sewerage system in part of the project area, wastewater is illegally discharged into storm water drains at various locations, polluting the receiving water bodies. The proposed provision of sewerage system will prevent the entry of wastewater into drainage system.

12. At present GCC is having an effective solid waste management system. However, the people living nearer the surface water bodies and the commercial pockets existing near surface water bodies are having tendency to dump solid waste near the water bodies. Therefore, the following measures are proposed to avoid disposal of solid waste into drains and canals.

(i) Major and micro drains are designed as box type drain with cover on top which will prevent dumping of solid waste in drains.
(ii) Fencing on both sides of major surplus canals sections where required
(iii) Provision of screens at discharge points in drains to control solid waste entry
(iv) Public awareness programs have been proposed to ensure public co-operation for proper waste disposal.

## D. Issues in Existing Storm Water Drainage System

13. The SWD facilities in Kosasthalaiyar Basin has the following basic problems.

(i) Rapid urbanization and increase in population has direct impact on the natural drainage course (shrinking of drains), due to this during incessant rain, flood occurs in the surroundings
(ii) Natural drain course from several lakes/tanks up to discharge end are observed to be missing.
(iii) Natural flow of the water in the drains are obstructed by the presence of the wild vegetation/ weeds
(iv) Some of the areas does not have sewerage system. Sewage & storm water gets mixed up which stagnates in the low-lying areas
(v) Lack of side drains along the roads causes flooding/ ponding of water
(vi) Due to improper drainage network, overflow of several drains occur during the rain. Due to this, roads in several locations are being badly affected and damaged

(vii) The existing pumping station located at Kargil Nagar is equipped with two nos. of 10 HP pumps having capacity of 2833 litres per minute (LPM) each and 3m diameter sump was constructed to pump the local rain water during floods. Based on the assessment, the existing pumps are very old and not having sufficient capacity to pump the rain water during floods

(viii) Due to the encroachments, the canal connecting Retteri north surplus (Canal) and the Puzhal surplus (Canal) has been shrunken and the flow of water has been completely stopped, due to this Retteri lake experiencing severe floods during monsoon season

(ix) Open drains that presently convey sullage are silted up hindering free flow of rainwater from the catchments areas. Stagnation of water because of siltation / blockage is creating health related problems due to mosquito breeding, fly nuisance etc.

(x) Flow of sewage / septic tank effluent and industrial effluents in some open drains also creates health risk to the citizen.

(xi) Dumping of debris & wastages into the Canals and lakes causing obstruction to free flow of rain water finally leading to overflowing and flooding of adjacent areas.

## E. Floods in the Project Area

14. The Kosasthalaiyar basin in GCC is located on Coromandel Coast off the Bay of Bengal. This region has been battered by incessant heavy rainfall causing water stagnation and inundation. In year 2005, project area continued to receive heavy rains, recording 241 mm in 24 hours on 28th October 2005, and 320 mm in 24 hours on 2nd December 2015. Total annual rainfall in 2005 and 2015 is 2,431.5 mm and 2,313.6 mm. GCC has been faced the problem of floods in many low - lying areas of the Kosasthalaiyar basin. Locations of inundated areas are shown in Figure 3. Due to inundation, there was heavy damages to structures, household articles and there was no food and power supply to the local people. Information regarding the flood-prone areas was collected by physical verification on-site, interacting with the local people and with the officials of GCC. About 121 flooding /inundation hot spots have been identified.

**Figure 3: Flood Prone Areas**


## F. Cause behind Flooding

(i) Poor coverage of drains i.e., only 8% are covered with effective drains at present.
(ii) Poor condition of existing drains i.e., out of total 280 km drains, only 110 km are structurally and hydraulically suitable.
(iii) Poor maintenance
(iv) Topographical issues, most of the area is plain and low lying, and the manmade boundaries such as rail lines, Buckingham canal, etc. criss-cross the area, further affecting the drainage and leading to flooding and water logging.

## G. Proposed Storm Water Drain Components

15. Towards developing a comprehensive storm water drainage system in Chennai City, the Detailed Project Report (DPR) has been prepared for providing Integrated Storm Water Drains in the four major basins during the year 2014. In first stage, works have been commenced in Adyar and Cooum basins with World Bank funding under Tamil Nadu Sustainable Urban Development Project (TNSUDP). Now, GCC intends to take up the Kosasthalaiyar basin for implementation.

**Table 2: Salient features of the project**

| Sl. No. | Details | Information |
|---|---|---|
| 1 | Area of Greater Chennai Corporation | 426 $km^2$ |
| 2 | Catchment Area considered in Kosasthalaiyar Basin within Corporation based on topography | 127.80 $km^2$ |
| 3 | Population of project area (2011 Census) | 2.58 million |
| 4 | Ground elevation range (MSL) | -0.41 to 26.96 m |
| 5 | Total road network (based on surveys conducted) | 1,315 km |

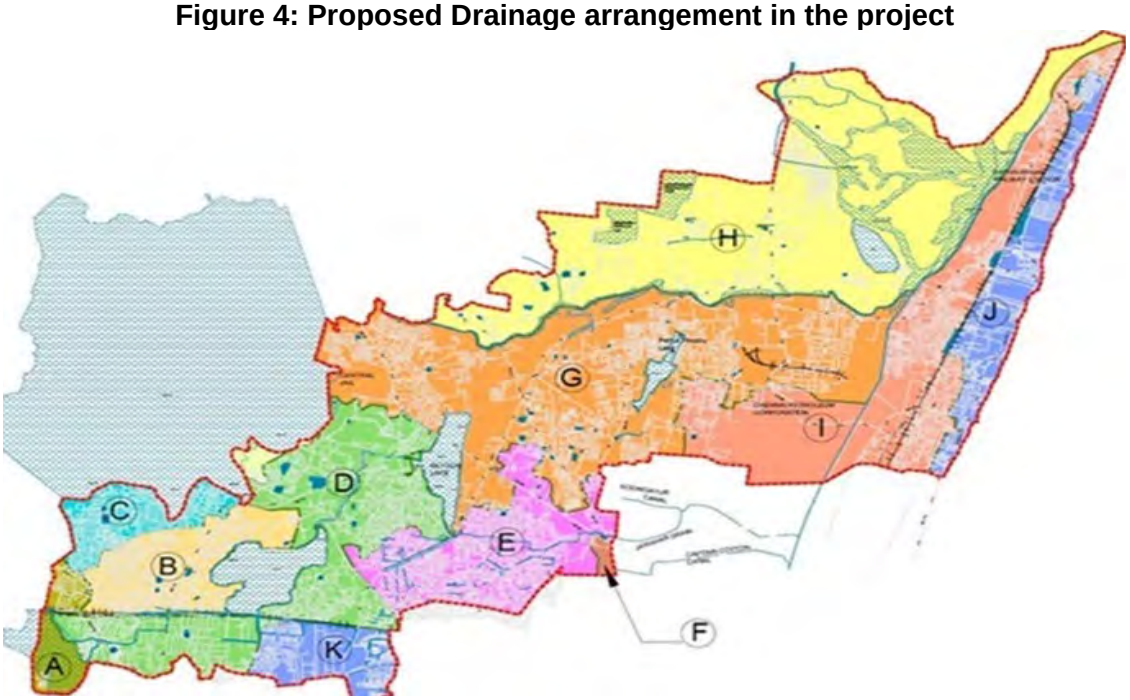
| Sl. No. | Details | Information |
|---|---|---|
| 6 | No. of major and minor water bodies | 8 Nos + 66 Nos. |
| 7 | Water ways (River/ Canal) | 7 Nos + 5 Nos. |
| 8 | Average Annual Rainfall | 1,317.7 mm |
| 9 | Highest rainfall recorded in the year (2015) in a day | 320 mm |
| 10 | Severely affected Flood Prone Area | 11.27 $km^2$ |
| 11 | % of area severely vulnerable to flood | 8.82% |
| 12 | Total Estimated Project Cost (GCC+PWD Component) | INR 26140.6 million |
| 13 | Total Annual O&M Cost | INR 382.6 million |
| 14 | Project Implementation Agency | Greater Chennai Corporation |
| 15 | Total Number of Packages | 46 |
| 16 | Total Project Implementation Period | 36 Months |

16. **Proposed Storm Waste Management System.** The project area spread over 127.8 $km^2$, has been divided into 11 storm water drainage zones (watersheds). These watersheds have different characteristics of their own having different types and land use pattern that affect the runoff. They have different soil characteristics, different permeability and flood absorption characteristics. Entire project area drains into Bay of Bengal mainly through Kosasthalaiyar River. The details of the watersheds are given in the following table.

**Table 3: Watersheds in Kosasthalaiyar Basin**

| Sl.no | Watershed | Catchment area ($km^2$) | Discharge Point | Figure 4 reference |
|---|---|---|---|---|
| 1 | North Ambattur | 2.06 | Ambattur Lake | A |
| 2 | Korattur Lake | 8.32 | KoratturLake &Kolathur Lake | B |
| 3 | Puzhal South | 3.38 | Puzhal Lake | C |
| 4 | Retteri Lake | 17.07 | Retteri Lake | D |
| 5 | Retteri South Surplus | 9.43 | Buckingham Canal | E |
| 6 | Captain Cotton Canal West | 0.29 | Buckingham Canal | F |
| 7 | Puzhal Surplus South | 29.52 | Madhavaram Periyathoppu Lake to Kosasthalaiyar River | G |
| 8 | Puzhal Surplus North | 31.23 | Kadapakkam Lake, Ariyalur Lake, Sadayankuppam Lake to Kosasthalaiyar River | H |
| 9 | North Buckingham canal | 16.64 | North Buckingham canal | I |
| 10 | North Coast Watershed | 6.14 | Bay of Bengal | J |
| 11 | Otteri Nallah Watershed | 3.72 | Otteri Nallah/drain | K |
| | **Total** | **127.8** | | |

**Figure 4: Proposed Drainage arrangement in the project**




17. Storm water system is designed adopting a 2-year return period to handle higher precipitation under extreme rainfall events, sea level rise in vulnerable coastal areas, and storm surges from cyclones. The proposed storm water drainage system features climate-resilient design to cope with intensifying rainfall and higher sea level rise. Infiltration pits are proposed to l boost groundwater recharge in paved areas of a region at risk of water scarcity. Off 280km of the existing storm water drains, nearly 105 km length is in good condition and those which are hydraulically adequate will be retained. The remaining 175 km of existing drain will be rehabilitated or replaced. New storm water drains for a length of 588 km constructed to cover the uncovered areas, this includes necessary interlinking of water bodies within the project area through the existing or proposed drains have also been considered to maintain the water balance and achieve maximum water storage within the Kosasthalaiyar drainage basin. Proposed project components are presented in the following Table 4. Watershed-wise proposals to improve existing and construction of new drains is given in Table 5.

**Table 4: Proposed Project Components**

| Sl.no | Watershed | Quantity |
|---|---|---|
| 1 | Construction of new drains of size range of 0.60 x 0.75m to 7.00 x 2.50m for a length of 588 km | 588 km length<br>Drain sizes varies from 0.60 (wide) x 0.75m (deep) to 7.00 (wide) x 2.50 m (deep) |
| 2 | Rehabilitation and/or replacement of existing storm water drains, including desilting as required | 175 km length |
| 3 | Improvement of Ambattur, Korattur, Kadappakkam, and Ariyallur canals to enhance water carrying capacity including desilting as required | 11 km long canal stretches |
| 4 | Construction of energy-efficient water-pumping stations at Kargil Nagar and Eranavoor | 2 numbers |

| Sl.no | Watershed | Quantity |
|---|---|---|
| 5 | infiltration pits constructed at regular intervals in roadside drains to recharge the groundwater aquifer | 23,000 numbers |

**Table 5: Watershed wise Drain Summary**

| Watershed Name | Existing network length (km) | Retained network length (km) | Total Proposed Network | | | Total Network Length (km) |
|---|---|---|---|---|---|---|
| | | | Redesigned | New Drains network Length (km) | Total (km) | |
| | Length (km) | Length (km) | network Length (km) | network Length (km) | | |
| North Ambattur -A | 9.69 | 5.71 | 3.94 | 2.64 | 6.58 | 12.29 |
| Korattur Lake – B | 23.15 | 8.56 | 14.59 | 50.71 | 65.30 | 73.86 |
| Puzhal South – C | 6.59 | 1.16 | 5.49 | 36.07 | 41.56 | 42.72 |
| Retteri Lake – D | 66.59 | 24.39 | 42.20 | 88.59 | 130.79 | 155.18 |
| Retteri South Surplus - E | 39.36 | 14.02 | 25.34 | 98.03 | 123.37 | 137.39 |
| Captain Cotton Canal West - F | 0.3 | 0 | 0.3 | 1.67 | 1.97 | 1.97 |
| Puzhal Surplus South - G | 51.19 | 17.79 | 33.40 | 119.17 | 152.57 | 170.36 |
| Puzhal Surplus North - H | 8.39 | 2.3 | 6.09 | 67.03 | 73.12 | 75.43 |
| North Buckingham canal - I | 50.80 | 20.83 | 29.97 | 69.94 | 99.91 | 120.74 |
| North Coast Watershed – J | 8.69 | 1.97 | 6.72 | 46.29 | 53.01 | 54.98 |
| Otteri Nallah - K | 15.12 | 8.27 | 6.85 | 8.42 | 15.27 | 23.54 |
| **Total** | **279.87** | **105.00** | **174.89** | **588.56** | **763.45** | **868.45** |
| | | | **Total Proposed Network = 763.45** | | | |

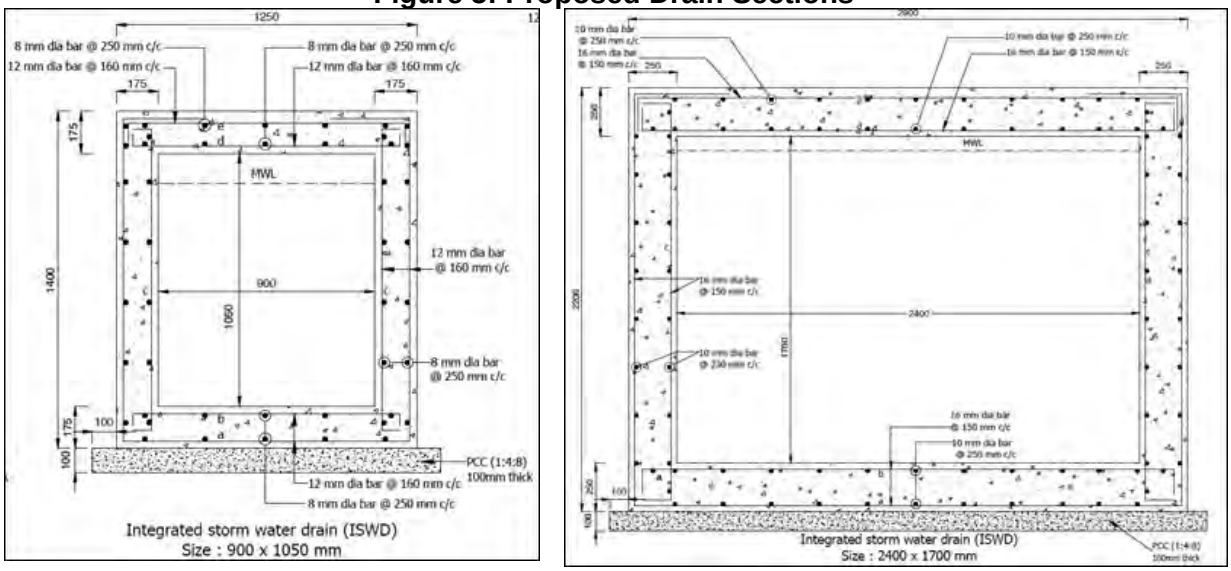
*Source: Final DPR of Kosasthalaiyar ISWD*

### 1. Proposed Type of Drains

18. It is proposed to construct drains in reinforced cement concrete (RCC) - M-20 grade of concrete with reinforcement. Size of drain varies and will be based on discharge capacities. The stability and other structure analysis have been carried while adopting the sections. The size of drains ranges from a minimum of 600 mm (wide) x 750 mm (deep) to a maximum of 7000 mm (wide) x 2500 mm (deep). Most of the newly proposed drains are along the roadsides. Reconstruction/augmentation of existing drains has been proposed which were found inadequate. Closed drains are proposed along roadsides for sizes ranging from 600 mm x 750 mm to 2500 mm x 2500 mm. Open drains are proposed for sizes above 2500 mm x 2500 mm.

19. For closed drains, RCC cover slabs are proposed with heavy-duty FRC (fiber reinforced concrete) inspection door for maintenance at an equal interval of about 10 m. The inspection door has been provided in close spacing for easy access for maintenance and desilting. Other components are the construction of silt catch pits and silt catch pits with rainwater harvesting structures, fencing on both sides of open drains to prevent dumping of solid wastes where needed, gratings in closed drains for entry of surface flow and to prevent the entry of solid wastes into the system, etc.

**Figure 5: Proposed Drain Sections**




## 2. Proposed Storm Water Pumping Stations

20. The existing storm water (drainage) pumping capacity at Kargil Nagar will be enhanced with an additional pumping station with 3 nos. having higher capacity pumps. A new storm water pumping station is proposed to avoid flood in Ernavoor. Storm water drains in Kargil Nagar and Ernavoor will be extended to the pumping stations. Adequate and accessible government owned vacant land is available on the bank of Buckingham canal (1,100 $m^2$ available, while 550 $m^2$ required at both sites) where the pumping stations are proposed. In both the pumping stations, storm water will be discharged to Buckingham Canal through pumping.

**Location of proposed storm water pumping station at Kargil Nagar**

**Location of proposed storm water pumping station at Eranavoor**

## 3. Proposed Surplus Canals Works

21. To improve the overall storm water drainage system in the project area, four out of seven surplus canals / macro drains in the project area, managed by PWD, is also proposed for improvement as part of this ADB funded Project. Total length is 11.25 km, and details are given in below table. Improvement works related to remaining three surplus canals (Retteri Surplus, 2.01 km; Puzhal Surplus, 12.23 km and Thanikachalam Drain, 3.62 km) will be undertaken by the PWD for which DPR has already been prepared by the PWD. The details of the canals are given in the following Table 6. Improvements proposed for each surplus canal is discussed below.

**Table 6: Surplus Canals Proposed for Improvement**

| Sl No. | Major Surplus Canal | Connecting Lake | | Length (km) |
|---|---|---|---|---|
| | | From | To | |
| 1 | Ambattur Surplus Canal | Ambattur | Korattur Lake | 5.79 |
| 2 | Korattur Surplus Canal | Korattur | Retteri Lake | 2.13 |
| 3 | Kadapakkam Surplus Canal | Kadapakkam Lake | Ariyalur Lake | 0.68 |
| 4 | Ariyalur Surplus Canal | Ariyalur Lake | Puzhal Surplus | 2.65 |
| **Total** | | | | **11.25** |

(i) **Ambattur Surplus Canals**: It carries the surplus water from Ambattur Lake to Korattur Lake. Presently this canal is lined with RCC and at some sections it has stone masonry and unlined. In addition, there are some missing links. This Canal is hydraulically analysed and found inadequate at some stretches and suggested trapezoidal RCC M30 sections size varying from 5 to 10 m wide.

(ii) **Korattur Surplus Canals:** It carries the surplus water from Korattur Lake to Retteri Lake. The average width is 40 m, and it is unlined in most of the stretches. This Canal is hydraulically analysed and found inadequate at some sections due to reduction of the section because of silting. It is proposed to de-silt this Canal to the depth of 1 to 2m to arrive the design section and strengthen sides with RCC M30 retaining walls.

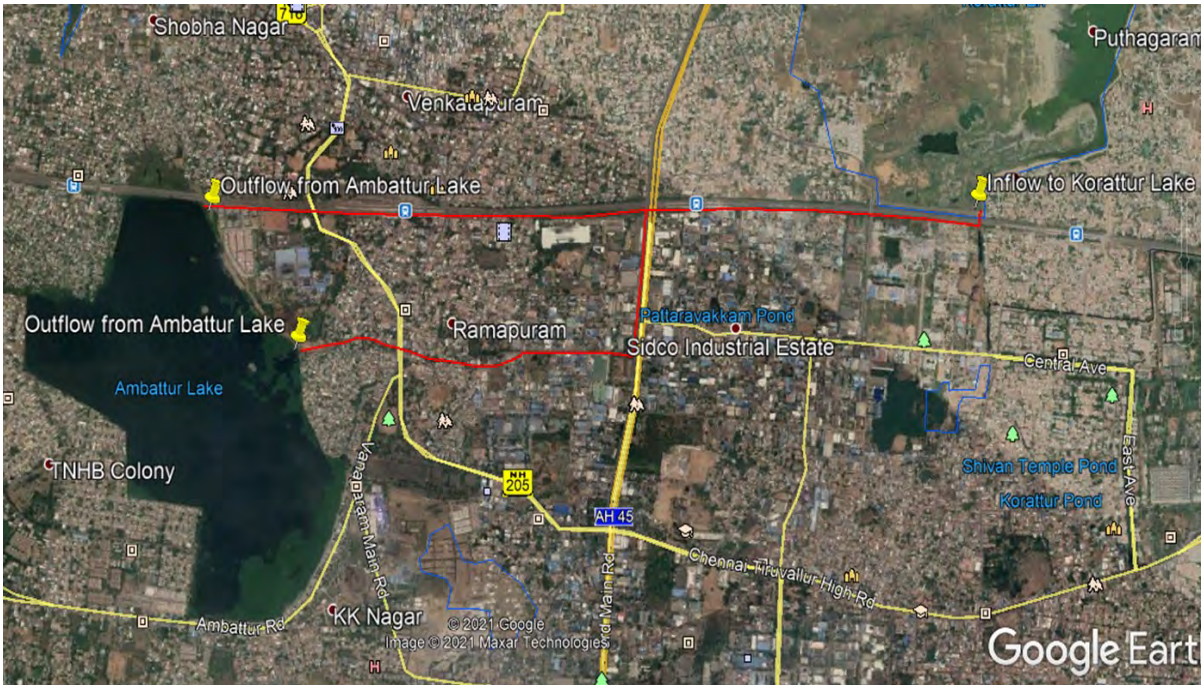
(iii) **Kadapakkam and Ariyalur Surplus Canals**: These two canals will carry surplus water from Kadapakkam Lake to Puzhal Surplus Canal via Ariyalur Lake. The existing earthen link between Kadapakkam Lake and Ariyalur Lake at present, shall be developed to a fully lined channel. From Ariyalur Lake to Puzhal surplus,

presently, this canal is unlined, earthen and in irregular shape. It is proposed to de-silt this Canal to the depths of 1 to 2m to arrive at the design section and strengthen sides with RCC retaining walls.

**Ambattur Surplus Canal**

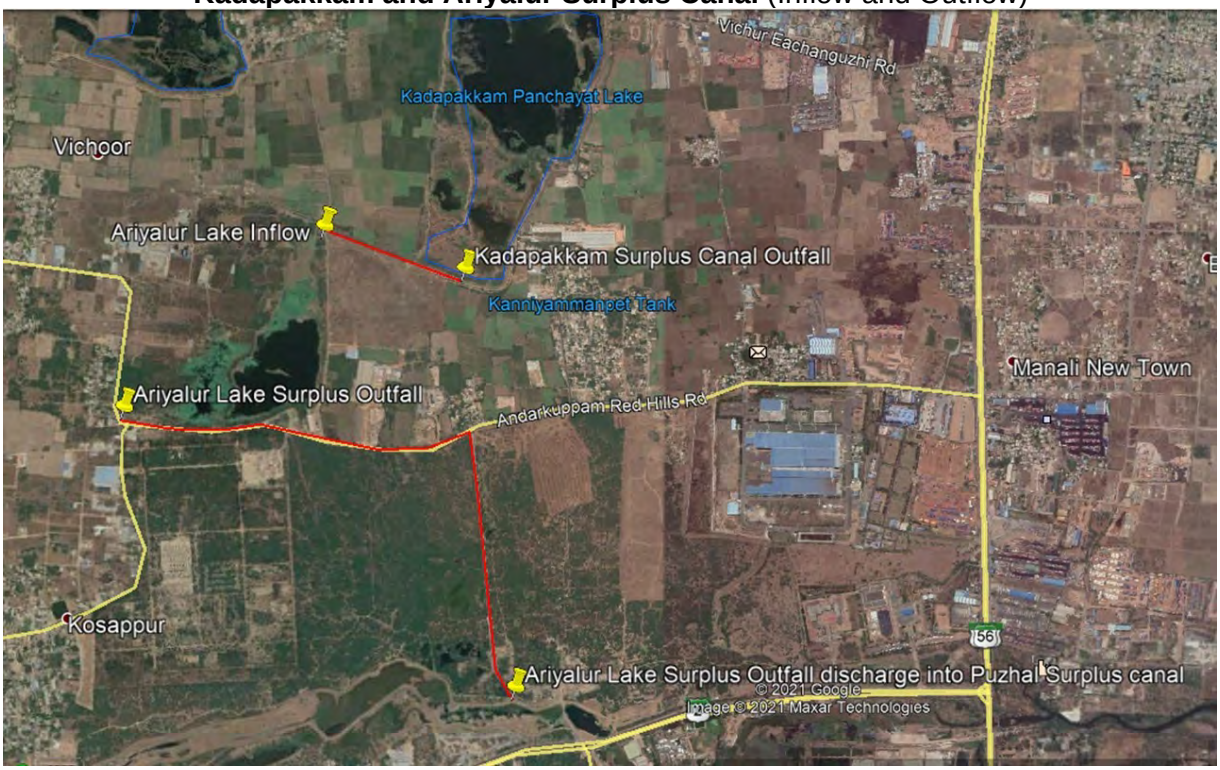
**Korattur Surplus Canal**

**Ambattur Surplus Canal Outfall to Korattur Lake**



**Korattur Lake Inflow and Outflow**


**Kadapakkam and Ariyalur Surplus Canal** (Inflow and Outflow)




22. **Design Considerations**. The macro drains/surplus canals connecting major lakes will consist of different section size of RCC retaining walls. The selection of the section size to be built

will be based on discharge capacities. These sections have been constructed by M-30 grade of concrete with reinforcement. The stability and other structure analysis have been carried while adopting this section. These section sizes ranges from a minimum of 4000 mm x 2000 mm to a maximum of 30,000 mm x 2,000 mm. Open drains with both side retaining walls with RCC base is proposed. In addition, the following interventions are proposing for new construction:

(i) Surplus canals are proposed to strengthen with RCC side walls and it is recommended to close / plug the illegal industrial effluent connections during construction of RCC walls and notify the pollution control board for further necessary action
(ii) All the proposed roadside drains are to be constructed using RCC M20 grade concrete and sidewalls for surplus canals shall be constructed using RCC M30.
(iii) If road width is less than 3 m and in newly added villages and undeveloped areas, Kerb & Gutter is proposed.

23. **Associated facilities**. Of the seven macro drains / surplus canals, four are being improved under this Project and the remaining three surplus canals/ macro drains namely Retteri Surplus (2.01 km), Puzhal Surplus (12.23 km) and Thanikachalam Drain (3.62 km) will be improved by the PWD of GOTN. PWD has already the DPR has been prepared. As per the SPS "associated facilities" are those that are not funded as part of the project (funding may be provided separately by the borrower/client or by third parties), and whose viability and existence depend exclusively on the project and whose goods or services are essential for successful operation of the project". These surplus canals already exist and proposed improvements although required, may not be essential for the viability of the ADB project.

## H. Implementation Schedule

24. The IUFMCKB project in Kosasthalaiyar Basin of Greater Chennai Corporation will be implemented by the Storm Water Drain Department of the Greater Chennai Corporation. Project area covers GCC Zones of I, II, III and part of Zones VI, VII & VIII. Entire scope of work under the project is split into 46 construction packages, which are further into 3 phases based on the severity of flood prone areas and topography i.e., upstream to downstream. Upstream locations are proposed under Phase 1 and downstream locations are proposed under Phase 2 and 3. All phases are being implemented simultaneously Details of phases and packages are given in the following table. Based on the volume of work in each package, the construction period varies between 24 to 36 months. Bidding process is almost completed, and construction is likely to start soon.

**Table 7: Bidding document (Package wise) information**

| Packages | Work details | Length in km |
|---|---|---|
| Package 1 | Construction of integrated storm water drain in North Ambattur Watershed | 6.6 |
| Package 2 | Construction of integrated storm water drain in North Korattur Lake watershed | 47.6 |
| Package 3 | Construction of integrated storm water drain in Korattur Lake Watershed | 17.9 |
| Package 4 | Construction of integrated storm water drain in Puzhal South Watershed | 14.6 |
| Package 5 | Construction of integrated storm water drain in Puzhal South Watershed | 22.6 |
| Package 6 | Construction of integrated storm water drain in Retteri Lake Watershed | 30.6 |
| Package 7 | Construction of integrated storm water drain in Retteri Lake Watershed | 26.0 |
| Package 8 | Construction of integrated storm water drain in Retteri Lake Watershed | 46.1 |
| Package 9 | Construction of integrated storm water drain in Retteri Lake Watershed | 5.2 |

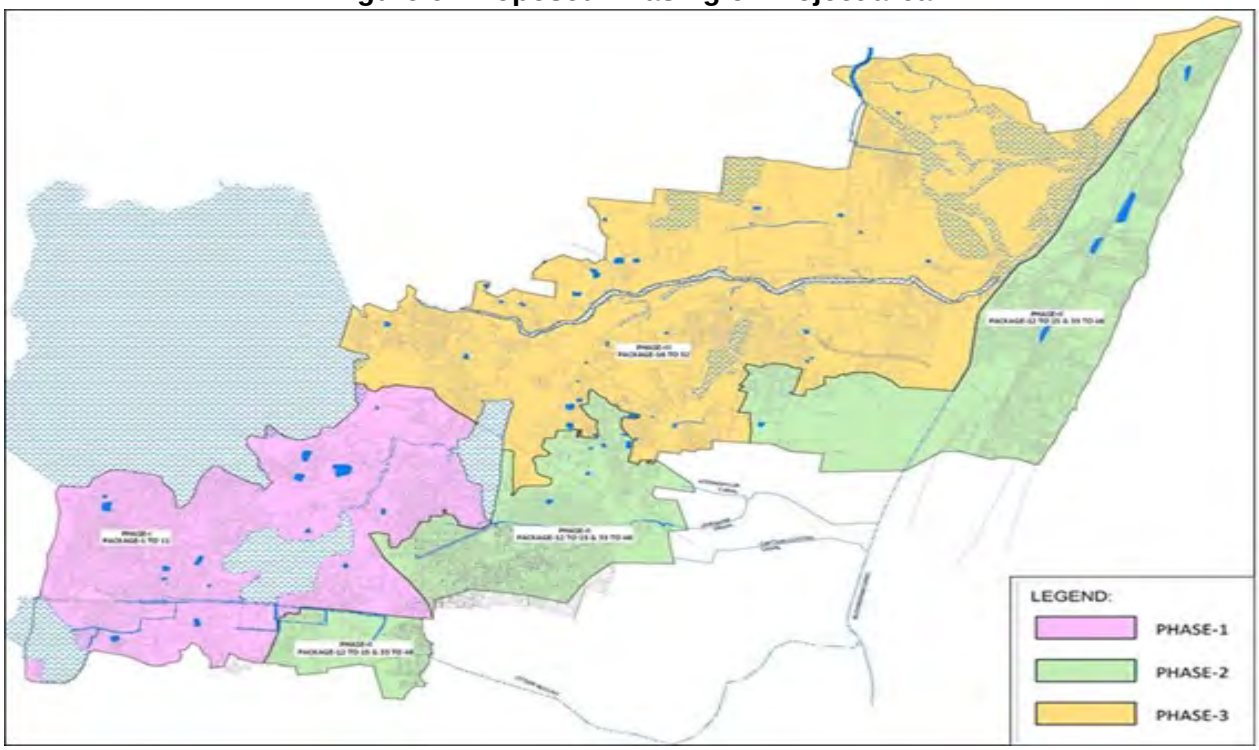
| Packages | Work details | Length in km |
|---|---|---|
| Package 10 | Construction of integrated storm water drain in Retteri Lake Watershed | 17.6 |
| Package 11 | Construction of integrated storm water drain in Retteri Lake Watershed | 4.0 |
| Package 12 | Construction of integrated storm water drain in Retteri South Surplus Watershed | 13.0 |
| Package 13 | Construction of integrated storm water drain in Retteri South Surplus Watershed | 32.8 |
| Package 14 | Construction of integrated storm water drain in Retteri South Surplus Watershed | 34.7 |
| Package 15 | Construction of integrated storm water drain in Retteri South Surplus Watershed and Captain Cotton Canal Watershed | 44.6 |
| Package 16 | Construction of integrated storm water drain in Puzhal Surplus South Watershed | 13.5 |
| Package 17 | Construction of integrated storm water drain in Puzhal Surplus South Watershed | 14.5 |
| Package 18 | Construction of integrated storm water drain in Puzhal Surplus South Watershed | 11.9 |
| Package 19 | Construction of integrated storm water drain in Puzhal Surplus South Watershed | 26.9 |
| Package 20 | Construction of integrated storm water drain in Puzhal Surplus South Watershed | 4.3 |
| Package 21 | Construction of integrated storm water drain in Puzhal Surplus South Watershed | 13.1 |
| Package 22 | Construction of integrated storm water drain in Puzhal Surplus South Watershed | 16.0 |
| Package 23 | Construction of integrated storm water drain in Puzhal Surplus South Watershed | 9.8 |
| Package 24 | Construction of integrated storm water drain in Puzhal Surplus South Watershed | 14.4 |
| Package 25 | Construction of integrated storm water drain in Puzhal Surplus South Watershed | 14.3 |
| Package 26 | Construction of integrated storm water drain in Puzhal Surplus South Watershed | 13.2 |
| Package 27 | Construction of integrated storm water drain in Puzhal Surplus North Watershed | 11.4 |
| Package 28 | Construction of integrated storm water drain in Puzhal Surplus North Watershed | 15.6 |
| Package 29 | Construction of integrated storm water drain in Puzhal Surplus North Watershed | 9.7 |
| Package 30 | Construction of integrated storm water drain in Puzhal Surplus North Watershed | 20.4 |
| Package 31 | Construction of integrated storm water drain in Puzhal Surplus North Watershed | 10.9 |
| Package 32 | Construction of integrated storm water drain in Puzhal Surplus North Watershed | 13.4 |
| Package 33 | Construction of integrated storm water drain in North Buckingham Canal Watershed | 9.1 |
| Package 34 | Construction of integrated storm water drain in North Buckingham Canal Watershed | 13.0 |
| Package 35 | Construction of integrated storm water drain in North Buckingham Canal Watershed | 12.4 |
| Package 36 | Construction of integrated storm water drain in North Buckingham Canal Watershed | 16.0 |

| Packages | Work details | Length in km |
|---|---|---|
| Package 37 | Construction of integrated storm water drain in North Buckingham Canal Watershed *(Pumping Station PS1)* | 32.7 |
| Package 38 | Construction of integrated storm water drain in North Buckingham Canal Watershed *(Pumping Station PS2)* | 14.5 |
| Package 39 | Construction of integrated storm water drain in North Coast Watershed | 9.0 |
| Package 40 | Construction of integrated storm water drain in North Coast Watershed | 13.4 |
| Package 41 | Construction of integrated storm water drain in North Coast Watershed | 16.9 |
| Package 42 | Construction of integrated storm water drain in North Coast Watershed | 12.0 |
| Package 43 | Construction of integrated storm water drain in Otteri Nalla Watershed | 15.8 |
| Package 44 | Improvement to Ambattur and Korattur canals in Kosasthaliyar basin in the extended areas of Greater Chennai Corporation | |
| Package 45 | Improvement to Kadappakkam and Ariyallur canals in Kosasthaliyar basin in the extended areas of Greater Chennai Corporation | |
| Package 46 | Constructing catch pits with rainwater harvesting structures in existing storm water drains in Kosasthaliyar basin in the extended areas of Greater Chennai Corporation (Package 46) | |

**Table 8: Proposed Project Phases and Construction Period**

| SI No. | Phase | Construction Period (Months) | | |
|---|---|---|---|---|
| | | **36** | **30** | **24** |
| 1 | Number of Packages in Phase 1(11No.s) | 2 | 3 | 6 |
| 2 | Number of Packages in Phase 2 (18No.s) | 2 | 6 | 10 |
| 3 | Number of Packages in Phase 3 (17No.s) | | 4 | 13 |
| | **Total** | **4** | **13** | **29** |

**Figure 6: Proposed Phasing of Project area**



# III. ANALYSIS OF ALTERNATIVES

25. The SPS requires an analysis of project alternatives to determine the best method of achieving project objectives (which is providing an improved climate resilient urban flood protection infrastructure in the project area of Chennai–Kosasthalaiyar river basin) while avoiding or minimizing environmental impacts. Alternative analysis provides opportunity to integrate environmental considerations into early stages of project, so that adverse environmental impacts can be avoided or minimized by various alternatives. It also provides opportunity to study various options vis a vis costs, provides a logical base, via transparent process, assist in decision making, gaining public support and ultimately in project approvals and timely implementation.

26. Various alternatives are examined for this urban drainage improvement project are presented below.

## A. 'No Project' Alternative

27. Project area is spread over 127.80 sq. km and is situated on the coromandel coast of the Bay of Bengal. Due to its coastal location, and it's almost flat topography, and is vulnerable to water logging and flooding during rains. Anthropogenic activities, inadequate infrastructure and rapid urbanization and increase in population has further aggravated the situation. The existing storm water drainage network inadequate and under capacity and covers only a part (8% ) of the study area. While the total road network is 1,315 km, the length of existing drains is just 280 km, and of which more than 60% of the drains are not hydrologically or structurally suitable and are in the need of rehabilitation and improvement. Some of the localities in the project area are low lying. About 11 sq. km, which is about 9% of the project areas is considered as severely vulnerable to floods. Obstruction to flow caused by missing links, blockages due to heavy silt and vegetation growth in the drain section, discharge of sewage into storm water drains, lack of roadside drains and overflowing drains due to inadequate capacity, lack of adequate capacity of pumping facilities in low lying areas and disposal of solid waste into drains are some of the issues faced by the drainage system in the project area.

28. Although project area has a good number of major and minor water bodies, river and canals, due to lack of proper connections, and the water holding capacity of the study area has been reduced over the period, and this is also identified as one of the reasons for flooding and water logging. In project area, 121 flooding /inundation hot spots have been identified.

29. This region, including the project area, has been experiencing heavy rains of late. On October 28, 2005, project area received record rainfall of 241 mm in just 24 hours due to incessant rains. Again in 2015, this record has been broken, and a very high rainfall of 320 mm is received just in 24 hours on December 2, 2015. Total annual rainfall in 2005 and 2015 is 2,431.5 mm and 2,313.6 mm. Given lack of proper infrastructure compounded by a very high rainfall, GCC has been faced the problem of floods. Due to inundation, there was heavy damages to structures, household articles and there was no food and power supply to the local people. The cost of relief rehabilitation including infrastructure repairs and restoration in the event of flooding is also enormous.

30. No project alternative meant maintenance of status quo in the project area in terms of its urban drainage and flood projection infrastructure. It is, therefore, the 'no project scenario', meant not only continuation of above problems but also further decline in living conditions and overall quality of life of pipe living in the project area. Therefore, 'no project alternative' is rejected.

## B. Project Location Alternative

31. Project area – Chennai-Kosasthalaiyar basin is one of the four major basins in Chennai City, and GCC initiate projects to comprehensively develop storm water drainage system covering all basins. As a first step, the GCC has initiated the improvement of storm water drainage system in Adyar and Cooum basins with financial support from the World Bank, the project is in the verge of completion. A similar project for the Kovalam basin is contemplated with financial support from the KfW. This project with ADB financial support will improve the storm water drainage infrastructure and address issues inter alia relating to water stagnation and inundation the Kosthalaiyar basin.

32. Proposed repair, rehabilitation and desilting works of existing drains (175 km) and surplus canals (11 km) will be conducted within the existing footprint of the facilities. Existing drains are mostly located along the roads. New drains of 588 km are proposed along the roads in the town within the road right-of-way (ROW). Sites for two pumping stations - at Kargil Nagar and Eranavoor are selected based on the technical considerations (lowest level and availability of discharge point) on a government owned vacant land. At Kargil Nagar, where there is already a pluming station, the new one will be constructed adjacent to the existing pumping station, and on a vacant government land.

## C. Design Alternatives

33. At present, entire project area drains into Bay of Bengal mainly through Kosasthalaiyar River. Proposed project design follows the existing natural drainage system completely and is divided 11 storm water drainage zones (watersheds) to account for site specific design in terms of land use, soil characteristics, water retention capacity etc., Outlet discharge points are defined by natural drainage pattern. Pumping systems are avoided, except in two places where the natural ground level is lower than the canal level.

34. A 2-year return period to handle higher precipitation under extreme rainfall events, sea level rise in vulnerable coastal areas, and storm surges from cyclones is adopted. Infiltration pits are proposed to boost groundwater recharge. Various other measures are included in design to achieve maximum water storage within the Kosasthalaiyar drainage basin.

35. Concrete drains are proposed with appropriate grade of concrete and reinforcement. Drains are designed with appropriate covers, inspection doors, silt catch pits, rainwater harvesting structures, fencing on both sides of open drains to prevent dumping of solid wastes where needed, gratings in closed drains for entry of surface flow and to prevent the entry of solid wastes into the system, etc. Design improvements will plug illegal industrial effluent connections.

# IV. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

## D. ADB Safeguard Policy Statement, 2009

36. ADB SPS[2] requires borrowers to meet a set of requirements (Safeguards Requirements 1) when delivering environmental safeguards for projects supported by ADB. The objectives are to ensure the environmental soundness and sustainability of projects, and to support the integration of environmental considerations into the project decision-making process. Hence, the project is requires to comply with these requirements. Summary of the step-by-step process is discussed below in this section.

37. **Screening and categorization.** The nature of the environmental assessment required for a project depends on the significance of its environmental impacts, which are related to the type and location of the project; the sensitivity, scale, nature, and magnitude of its potential impacts; and the availability of cost-effective mitigation measures. Projects are screened for their expected environmental impacts, and are assigned to one of the following four categories:

(i) **Category A**. A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment (EIA) is required.
(ii) **Category B**. A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for projects classified as Category A. An initial environmental examination (IEE) is required.
(iii) **Category C**. A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed.
(iv) **Category FI**. A proposed project is classified as category FI if it involves investment of ADB funds to or through a financial intermediary.

38. **Environmental Management Plan.** PMU has prepared an EMP and included in Section VIII of this IEE report, as required for category B projects. The EMP shall describe and address the potential impacts and risks identified by the environmental assessment. The level of detail and complexity of the EMP and the priority of the identified measures and actions will be commensurate with the project's impact and risks. The EMP shall include the proposed mitigation measures, environmental monitoring and reporting requirements, emergency response procedures, related institutional or organizational arrangements, capacity development and training measures, implementation schedule, cost estimates, and performance indicators.

39. **Public Disclosure.** PMU shall submit the following documents to ADB for disclosure on ADB website so affected people, other stakeholders, and the public can provide meaningful inputs into the project design and implementation:[3]

(i) Final or updated IEE upon receipt; and

[2] ADB. 2009. *Safeguard Policy Statement*. Manila.
[3] Per ADB SPS, 2009, prior to disclosure on ADB website, ADB reviews the "borrower's/client's social and environmental assessment and plans to ensure that safeguard measures are in place to avoid, wherever possible, and minimize, mitigate, and compensate for adverse social and environmental impacts in compliance with ADB's safeguard policy principles and Safeguard Requirements 1-4."

(ii) Environmental monitoring reports submitted by the implementing agency during project implementation upon receipt.

40. **Consultation and Participation.** The GCC/PMU shall carry out meaningful consultations[4] with affected people and other concerned stakeholders, including civil society, and facilitate their informed participation. The consultation process and its results are to be documented and reflected in the environmental assessment report.

41. **Grievance Redress Mechanism.** GCC/PMU shall establish a mechanism to receive and facilitate resolution of affected peoples' concerns, complaints, and grievances about the project's environmental performance. The grievance mechanism shall be scaled to the risks and adverse impacts of the project.

42. **Monitoring and Reporting.** GCC/PMU shall monitor, measure, and document the progress of implementation of the EMP. If necessary, GCC/PMU will identify the necessary corrective actions, and reflect them in a corrective action plan. GCC/PMU will prepare and submit to ADB semi-annual environmental monitoring reports that describe progress with implementation of the EMP, and compliance issues and corrective actions, if any.

43. **Unanticipated Environmental Impacts.** Where unanticipated environmental impacts become apparent during implementation, GCC/PMU shall update the environmental assessment and EMP, or prepare a new environmental assessment and EMP, to assess the potential impacts, evaluate the alternatives, and outline mitigation measures and resources to address those impacts.

44. **Pollution Prevention and Control Technologies.** During the design, construction, and operation of the project, the GCC/PMU will apply pollution prevention and control technologies and practices consistent with international good practice, as reflected in internationally recognized standards such as the World Bank Group's Environment, Health and Safety Guidelines. These standards contain performance levels and measures that are normally acceptable and applicable to projects. When Government of India and Government of Tamil Nadu regulations differ from these levels and measures, the GCC/PMU will achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, the PMU will provide full and detailed justification for any proposed alternatives that are consistent with the requirements presented in ADB SPS.

45. **Occupational Health and Safety.** GCC/PMU shall ensure that workers are provided with a safe and healthy working environment, considering risks inherent to the sector and specific classes of hazards in the project work areas, including physical, chemical, biological, and radiological hazards. PMU shall ensure to take steps to prevent accidents, injury, and disease arising from, associated with, or occurring during the course of work by (i) identifying and minimizing, so far as reasonably practicable, the causes of potential hazards to workers; (ii) providing preventive and protective measures, including modification, substitution, or elimination of hazardous conditions or substances; (iii) providing appropriate equipment to minimize risks and

[4] Per ADB SPS, 2009, meaningful consultation means a process that (i) begins early in the project preparation stage and is carried out on an ongoing basis throughout the project cycle; (ii) provides timely disclosure of relevant and adequate information that is understandable and readily accessible to affected people; (iii) is undertaken in an atmosphere free of intimidation or coercion; (iv) is gender inclusive and responsive, and tailored to the needs of disadvantaged and vulnerable groups; and (v) enables the incorporation of all relevant views of affected people and other stakeholders into decision making, such as project design, mitigation measures, the sharing of development benefits and opportunities, and implementation issues.

requiring and enforcing its use; (iv) training workers and providing them with appropriate incentives to use and comply with health and safety procedures and protective equipment; (v) documenting and reporting occupational accidents, diseases, and incidents; and (vi) having emergency prevention, preparedness, and response arrangements in place.

46. **Community Health and Safety.** The GCC/PMU shall ensure to identify and assess the risks to, and potential impacts on, the safety of affected communities during the design, construction, operation, and decommissioning of the project, and will establish preventive measures and plans to address them in a manner commensurate with the identified risks and impacts. GCC/PMU shall ensure to apply preventive and protective measures for both occupational and community health and safety consistent with international good practice, as reflected in internationally recognized standards such as the World Bank Group's Environmental, Health and Safety Guidelines.[5] PMU shall also adhere to necessary protocols in response to emerging infectious diseases such as the corona virus disease (COVID-19) consistent with the guidelines of relevant government healthcare agencies and the World Health Organization.

47. **Physical Cultural Resources.** GCC/PMU is responsible for siting and designing the project to avoid significant damage to physical cultural resources. Such resources likely to be affected by the project will be identified, and qualified and experienced experts will assess the project's potential impacts on these resources using field-based surveys as an integral part of the environmental assessment process. The chance finds procedure or protocol included in this IEE shall be used as mandatory guide for the contractor.

48. **Environmental Audit.** When a project involves existing activities or facilities, GCC/PMU is responsible to ensure that relevant external experts will perform environmental audits to determine the existence of any areas where such project may cause or is causing environmental risks or impacts. If the project does not foresee any new major expansion, the audit constitutes the environmental assessment for the project.

49. Based on the SPS 2009 requirements, this project "Proposed Integrated Urban Flood Management for the Chennai - Kosasthalaiyar Basin" has been categorized as "B" and accordingly this IEE has been prepared to address the potential impacts, in line with the recommended IEE content and structure for Category "B" projects.

## E. National Environmental Laws

50. **Environmental assessment.** The GoI EIA Notification of 2006 (replacing the EIA Notification of 1994) sets out the requirement for Environmental Assessment in India. This states that Environmental Clearance (EC) is required for specified activities/projects, and this must be obtained before any construction work or land preparation (except land acquisition) may commence. Projects are categorized as 'A' or 'B' depending on the scale of the project and the nature of its impacts.

51. **Category A** projects require EC from the central Ministry of Environment, Forests and Climate Change (MoEF&CC). The proponent is required to provide preliminary details of the project in the prescribed manner with all requisite details, after which an Expert Appraisal Committee (EAC) of the MoEF&CC prepares comprehensive Terms of Reference (TOR) for the EIA study. On completion of the study and review of the report by the EAC, MoEF&CC considers the recommendation of the EAC and provides the EC if appropriate.

[5] World Bank Group, 2007. *Environmental, Health, and Safety General Guidelines*. Washington, DC.

52. **Category B** projects require environmental clearance from the State Environment Impact Assessment Authority (SEIAA). The State level EAC categorizes the project as either B1 (requiring EIA study) or B2 (no EIA study) and prepares ToR for B1 projects within 60 days. On completion of the study and review of the report by the EAC, the SEIAA issues the EC based on the EAC recommendation. The Notification also provides that any project or activity classified as category B will be treated as category 'A' if it is located in whole or in part within 10km from the boundary of protected areas, notified areas or interstate or international boundaries.

53. Per the EIA Notification, 2006, the proposed project components do not fall under the ambit of the EIA Notification 2006, and therefore EIA study and environmental clearance requirement do not apply to this project. The project will not require environmental clearance either from SEIAA (at state level) or from MoEFCC (at central level).

54. **Applicable environmental regulations.** Besides EIA Notification 2006, there are various other acts, rules, policies, and regulations currently in force in India that deal with environmental issues that could apply to infrastructure development. The specific regulatory compliance requirements of the subproject are shown in Table 9.

**Table 9: Applicable Environmental Regulations**

| Law | Description | Requirement |
|---|---|---|
| Environment (Protection) Act, 1986 and CPCB Environmental Standards. | Emissions and discharges from the facilities to be created or refurbished or augmented shall comply with the notified standards | To comply with applicable notified standards |
| Water (Prevention and Control of Pollution) Act of 1974, Rules of 1975, and amendments | The act was enacted to provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water. Control of water pollution is achieved through administering conditions imposed in consent issued under this Act.<br><br>Under this law, it is mandatory to obtain consent from Tamil Nadu State Pollution Control Board (TNPCB) for discharge from construction activities. | No wastewater discharge anticipated from this storm water drainage project; no permission/clearance required under this Act<br><br>The contractor should obtain consent from TNPCB for discharge from construction activities.<br><br>Application has to be submitted online at http://tnocmms.nic.in/OCMMS/ |
| Noise Pollution (Regulation and Control) Rules, 2000 and amended | Rule 3 of the Act specifies ambient air quality standards in respect of noise for different areas/zones. | To comply with the CPCB Ambient Noise Standards. (see rule 3[1] and 4[1]) |
| Air (Prevention and Control of Pollution) Act, 1981, amended 1987 and its Rules, 1982. | Applicable for equipment and machinery's potential to emit air pollution (including but not limited to diesel generators and vehicles); | Equipment and machinery such as diesel generators, hot mix plants, wet mix plants, stone crushers, etc. if installed for construction to comply with applicable emission standards. |

| Law | Description | Requirement |
|---|---|---|
| The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008 | It provides for regulation and control of indiscriminate disposal of Hazardous waste; and its sound management to reduce risks to environmental and human health<br><br>Applicable if project deals with generation/ handling/ storage/ processing of hazardous waste which should take cognizance of the provisions/schedules of these Rules and obtain authorization from the TNSPCB. | Not applicable |
| Municipal Solid Wastes Management Rules, 2016 | Rules to manage municipal solid waste generated; provides rules for segregation, storage, collection, processing, and disposal. | The solid waste generated at proposed facilities shall be managed and disposed of by following the SWM Rules |
| Construction and Demolition (C & D) Waste Management Rules, 2016 | Rules to manage construction and waste resulting from construction, re-modelling, repair and demolition of civil structure. Rules define C & D waste as comprising of building materials, debris resulting from demolition / re-modelling or repairs | Construction and demolition waste generated from the project<br>construction shall be managed and disposed as per the rules |
| Central Ground Water Authority, Notification, 1997 | It provides for regulation and control of ground water development and management | Permission for the extraction of Groundwater for construction purposes from Central Groundwater Board (CGWB) |
| Tamil Nadu State Ground Water (Development and Management) Act, 2003 | This Act is to protect groundwater resources and provide safeguards against groundwater overexploitation, and to ensure its planned development and management; notifies areas for development, regulation and control of groundwater; prohibits sinking of wells and groundwater transport in notified areas without prior permission of the designated authority; requires all wells to be registered | Groundwater abstraction in any of the notified areas will be subject to the provisions of this Act. |
| Labor Laws | The contractor shall not make employment decisions based upon personal characteristics unrelated to job requirements. The contractor shall base the employment relationship upon the equal opportunity and fair treatment and shall not discriminate concerning aspects of the employment relationship, | **Appendix 2** provides applicable labor laws including amendments issued from time to time applicable to establishments engaged in the construction of civil works. |

<table>
<tr><th>Law</th><th>Description</th><th>Requirement</th></tr>
<tr><td></td><td>including recruitment and hiring, compensation (including wages and benefits), working conditions and terms of employment or retirement, and discipline. The contractor shall provide equal wages and benefits to men and women for work of equal value or type.</td><td></td></tr>
<tr><td>Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979</td><td>Act is applicable to any establishment that employs 5 or more inter-state migrant workers through an intermediary (who has recruited workers in one state for employment at an establishment situated in another state).</td><td>Contractor for subprojects to register with the Labour Department in case of hiring of inter-state migrant workers. Adequate and appropriate amenities and facilities to be provided to workers including housing, sanitation, portable water, medical aid, traveling expenses from home to work place, etc.</td></tr>
<tr><td>Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996</td><td>It regulates the employment and conditions of service of building and other construction workers and provides for their safety, health and welfare</td><td>This act is applicable for safeguarding the construction labours/ workers engaged in this subproject.</td></tr>
<tr><td>Coastal Regulation Zone (CRZ) Notification, 2018 dated 18/01/2019.</td><td>This notification under the Environment (Protection) Act, 1986 supplements the law on-site clearance by declaring certain zones as CRZ and regulates activities in these zones.<br><br>Permission from Coastal Regulation Zone authority is required for construction works in CRZ. Storm water drain is allowable activity in most of the CRZ zones, but permission will be required.<br><br>Definition of each zone that is falling under the project area is given below as per the CRZ Notification:<br><br>CRZ II - shall constitute the developed land areas up to or close to the shoreline, within the existing municipal limits or in other existing legally designated urban</td><td>Following project components are falling in the CRZ and will require prior permission for construction works.
<table>
<tr><th>Sl.no</th><th>Project Details in CRZ area</th><th>CRZ area</th><th>Length/ Area/No's</th></tr>
<tr><td rowspan="3">1</td><td rowspan="3">Storm water drains</td><td>CRZ II</td><td>59.059 km</td></tr>
<tr><td>CRZ IVA</td><td>0.451 km</td></tr>
<tr><td>CRZ IVB</td><td>1.210 km</td></tr>
<tr><td>2</td><td>Storm water Pumping Stations at Kargil Nagar and Ernavoor</td><td>CRZ II</td><td>979 $m^2$ (489.5 $m^2$ each)</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">Stormwater Outfall/ Discharge Points</td><td>CRZ II</td><td>6 nos</td></tr>
<tr><td>CRZ IVA</td><td>9 nos</td></tr>
<tr><td>CRZ IVB</td><td>14 nos</td></tr>
</table>
Accordingly, application in the prescribed format (Form 1, refer Appendix 16) and CRZ map[6] (as per the CRZ notification 2019) has</td></tr>
</table>

[6] Anna University, Chennaim, is one of the authorised agencies for preparing CRZ maps. As per the request from the

| Law | Description | Requirement |
|---|---|---|
| | areas, which are substantially built-up with a ratio of built-up plots to that of total plots being more than 50 per cent and have been provided with drainage and approach roads and other infrastructural facilities, such as water supply, sewerage mains, etc.<br><br>CRZ IVA - The water area and the sea-bed area between the Low Tide Line up to twelve nautical miles on the seaward side shall constitute CRZ-IV A.<br><br>CRZ-IV B areas shall include the water area and the bed area between LTL at the bank of the tidal influenced water body to the LTL on the opposite side of the bank, extending from the mouth of the water body at the sea up to the influence of tide, i.e., salinity of five parts per thousand (ppt) during the driest season of the year. | been prepared and submitted to the Tamil Nadu State Coastal Zone Management Authority (TNSCZMA) for approvals/ clearance |
| Ancient Monuments and Archaeological Sites and Remains Acts, 1958, its Rules, 1959 and notification, 1992.<br><br>Ancient Monuments and Archeological Sites and Remains (Amendment and Validation) Act, 2010 | This act provides, inter alia, for the preservation of ancient and historical monuments and archaeological sites and remains of national importance<br>• Notifies 100m around the monument as a prohibited area and 100 to 300m as a regulated area for construction works;<br>• No excavation/construction work is allowed within 100m of the boundary of the protected monument;<br>• Requires prior permission of National Monument Authority (NMA) for taking up works within 300m of the boundary of protected monuments | There are no protected monuments in project area.<br>Not applicable to the project. |

GCC, Anna university have conducted DGPS survey and marked the HTL, LTL on the CRZ map of 1:4000 scale (as per the approved CZMP).

55. **Costal Regulation Zone.** The areas located along the coast are designated as Coast Regulation Zones as per the CRZ Notification 2019 (superseding 2011 Notification). CRZ map of the project area is shown in:

56. **Figure 19**: The view of discharge outfall into Sea and Creek. Anna University, Chennai, is one of the authorized agencies for preparing CRZ maps in the country. As per the request from the GCC, Anna University has conducted the mapping exercise, for the purpose of clearance / no objection from Tamil Nadu Coastal Zone Management Authority (TNCZMA). Of the total 127.8 $km^2$ area, about 2.5 percent (3.19 $km^2$) fall under the CRZ. Some sections of the storm water drain, storm water pumping stations (at Kargil nagar and Ernavoor) and discharge/ outfall locations are located in CRZ II, CRZ IVA and CRZ IVB.

(i) CRZ II. Few sections of the Storm water drains proposed in the settlements located near the coast/ Bay of Bengal comes under the CRZ-II. The proposed (i) storm water pumping stations located at Kargil Nagar and Ernavoor, (ii) Storm water drain for a length of 59.059km and (iii) 6 storm water discharge points comes under the CRZ II.

(ii) CRZ IVA. As per the proposed storm water network design, it is planned to discharge the collected storm water through the existing discharge points to the sea (Bay of Bengal). Arrangements for the storm water discharge already has been included in the Ennore Expressway that runs along the coast. Sufficient drain provision has been included every 500m intervals in this road. In this project the existing drain outfall facility has been proposed to be utilized. Due to the erosion some of the drains are heavily silted and it shall be desilted for a length of 0.451 km. Hence, as per the CRZ notification 2019, the proposed activity comes under the CRZ IVA and mandated CRZ clearance.

(iii) CRZ IVB. As per the proposed design, improvements are required in the CRZ IVB for a length of 1.210 km, this includes siltation of the clogged drains (existing Drains) and 14 outfall/ discharge locations. Few of the outfalls in the Ennore Creek is indicated in the following map.

57. **Status of CRZ clearance.** GCC has submitted an application (Form 1) to District Coastal Zone Management Authority (DCZMA) in December 2020. DCZMA conducted the meeting in February 2021, after then forwarded the application to state-level TNCZMA for clearance. The state level meeting of TNCZMA is likely to be conducted in April 2021 to issue the clearance. No works will be started in CRZ until the TNCZMA clearance is obtained, and any conditions, if any imposed by TNCZMA are complied with. Of the total 46 packages proposed under the Project, components in CRZ are in 11 packages (Package numbers 27, 32, 34, 35, 36, 37, 38, 39, 40, 41 and 42). Works in these packages will be initiated only after clearance.

58. **Clearances/permissions to be obtained by the Contractor.** The following table shows the list of clearances/permissions required for project construction.

**Table 10: Clearances and Permissions required for Construction - GCC**

| S. No | Construction Activity | Statutory Authority | Statute under which Clearance is Required | Responsible |
|---|---|---|---|---|
| 1 | Construction of storm water drains, pumping stations | TNSCZMA | Clearance under the Coastal Regulation Zone Notification 2011 | PIU & PSC |

| S. No | Construction Activity | Statutory Authority | Statute under which Clearance is Required | Responsible |
|---|---|---|---|---|
| | and discharge points in CRZ area | | | |
| 2 | Tree Cutting | GCC | Clearances from the respective Regional Deputy / Joint Commissioner, GCC for cutting of trees. | PIU & PSC |

**Table 11: Clearances and Permissions required for Construction - Contractor**

| | | | | |
|---|---|---|---|---|
| 1 | Regulatory permits (license and insurance)__required concerning applicable labour laws | Government of Tamil Nadu Labour Department | Permits obtained by the contractor shall be periodically examined and validity is ensured. | Contractor |
| 2 | Hot mix plants, Crushers and Batching plants | TNPCB | Consent to establish and consent to operate under the Air Act, 1981 | Contractor |
| 3 | Discharges from construction activities | TNPCB | Consent to establish and consent to operate under Water Act, 1974 | Contractor |
| 4 | Storage, handling and transport of hazardous substances | TNPCB | Hazardous Wastes (Management and Handling) Rules. 1989 Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989 | Contractor |
| 5 | Sand mining, quarries and borrow areas | Department of Geology and mining, GoTN | Tamil Nadu Minor Mineral Concession Rules, 1959 (corrected up to 31.3.2001) | Contractor |
| 6 | For establishing new quarries and borrow areas | MOEF&CC | Environmental clearance under EIA Notification 2006 | Contractor |
| 7 | Groundwater Extraction | Public Works Department | (Groundwater) Tamil Nadu Groundwater Development and Management Act 2000 | Contractor |

59. **ADB SPS Requirements.** During the design, construction, and operation of the project, the PMU and PIU will apply pollution prevention and control technologies and practices consistent with international good practice, as reflected in internationally recognized standards such as the World Bank Group's Environment, Health, and Safety Guidelines. These standards contain performance levels and measures that are normally acceptable and applicable to projects. When the Government of India regulations differ from these levels and measures, the PMU and PIU will achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, the PMU and PIU will provide full and detailed justification for any proposed alternatives that are consistent with the requirements presented in ADB SPS.

**Table 12: WHO Ambient Air Quality Guidelines**

| Parameters | Averaging Period | Guidelines Value in µg/m$^3$ |
|---|---|---|
| Sulfur Dioxide ($SO_2$) | 24-hour<br><br><br>10 minutes | 125 (Interim Target-1)<br>50(Interim Target-2)<br>20(Guidelines)<br>500(Guidelines) |
| Nitrogen Dioxide ($NO_2$) | 1-Year<br>1-hour | 40 (Guidelines)<br>200 (Guidelines) |
| Particular Matter $PM_{10}$ | 1-Year | 70 (Interim target-1)<br>50 (Interim target-2)<br>30 (Interim target-3)<br>20(Guidelines) |
| | 24-hour | 150 (Interim target-1)<br>100 (Interim target-2)<br>75 (Interim target-3)<br>50(Guidelines) |
| Particular Matter $PM_{2.5}$ | 1-Year | 35 (Interim target-1)<br>25 (Interim target-2)<br>15 (Interim target-3)<br>10(Guidelines) |
| | 24-hour | 75 (Interim target-1)<br>50 (Interim target-2)<br>37.5 (Interim target-3)<br>25 (Guidelines) |
| Ozone | 8-hour daily Maximum | 160 (Interim Target-1)<br>100 (Guidelines) |

**Table 13: World Bank Group's EHS Noise Level Guidelines**

| Receptor | One Hour Leq (dBA) | |
|---|---|---|
| | Daytime 07.00-22.00 | Night Time 22.00 – 07.00 |
| Residential, Institutional educational | 55 | 45 |
| Industrial, Commercial | 70 | 70 |

**Table 14: Water Quality Standard as per WHO**

| Group | National Standards for Drinking Water | | | WHO Guidelines for Drinking-Water Quality, 4th Edition, 2011 | Applicable Per ADB, SPS |
|---|---|---|---|---|---|
| | Parameter | Unit | Max. Concentration Limit | | |
| Physical | Turbidity | NTU | 1 (5) | - | 1 (5) |
| | pH | | 6.5 – 8.5 | None | 6.5 – 8.5 |
| | Color | Hazen Units | 5 (15) | None | 5 (15) |
| | Taste and Odor | | Agreeable | - | Agreeable |
| | TDS | mg/l | 500 (2,000) | - | 500 (2,000) |
| | Iron | mg/l | 0.3 | - | 0.3 |
| | Manganese | mg/l | 0.1 (0.3) | - | 0.1 (0.3) |
| | Arsenic | mg/l | 0.01 (0.05) | 0.01 | 0.01 |
| | Cadmium | mg/l | 0.003 | 0.003 | 0.003 |
| | Chromium | mg/l | 0.05 | 0.05 | 0.05 |
| | Cyanide | mg/l | 0.05 | None | 0.05 |
| | Fluoride | mg/l | 1 (1.5) | 1.5 | 1 (1.5) |
| | Lead | mg/l | 0.01 | 0.01 | 0.01 |

| Group | National Standards for Drinking Water | | | WHO Guidelines for Drinking-Water Quality, 4th Edition, 2011 | Applicable Per ADB, SPS |
|---|---|---|---|---|---|
| | Parameter | Unit | Max. Concentration Limit | | |
| | Ammonia | mg/l | 0.5 | none established | 0.5 |
| Chemical | Chloride | mg/l | 250 (1,000) | none established | 250 (1,000) |
| | Barium | mg/l | 0.7 | None | 0.7 |
| | Sulphate | mg/l | 200 (400) | None | 200 (400) |
| | Nitrate | mg/l | 45 | 50 | 45 |
| | Copper | mg/l | 0.05 (1.5) | 2 | 0.05 (1.5) |
| | Total Hardness | mg/l | 200 (600) | - | 200 (600) |
| | Calcium | mg/l | 75 (200) | - | 75 (200) |
| | Zinc | mg/l | 5 (15) | none established | 5 (15) |
| | Mercury | mg/l | 0.001 | 0.006 | 0.001 |
| | Aluminum | mg/l | 0.1 (0.3) | none established | 0.1 (0.3) |
| | Anionic Detergents | mg/l | 0.2 (1.0) | None | 0.2 (1.0) |
| | Phenolic Compounds | mg/l | 0.001(0.002) | None | 0.001(0.002) |
| | Residual Chlorine | mg/l | 0.2 | 5 | 0.2 |
| Microbial | E-coli | MPN/100ml | Must not be detectable in any100 ml sample | Must not be detectable in any 100 ml sample | Must not be detectable in any 100 ml sample |
| indicator | Total Coliform | MPN/100ml | | | |

# V. DESCRIPTION OF THE ENVIRONMENT

## A. Methodology Used for Baseline Study

60. **Data collection and stakeholder consultations.** Data for this study has been collected through a comprehensive literature survey, field monitoring, discussion with stakeholder agencies, and field visits to the proposed subproject sites. The literature survey broadly covered the following:

(i) Project details, reports, maps, and other documents prepared by DPR consultants,
(ii) Discussions with ADB Consultants, GCC, DPR Consultants, and other relevant government agencies
(iii) Secondary data from previous project reports and published articles, and
(iv) The literature on land use, soil, geology, hydrology, climate, socioeconomic profiles, and other planning documents collected from Government agencies and websites.

61. Field monitoring survey and a secondary source of information broadly covered (i) Ambient air quality monitoring, (ii) Noise levels/ quality monitoring (iii) Silt sampling, (iv) Surface water sampling, (v) Groundwater sampling and (vi) Flora and Fauna assessment.

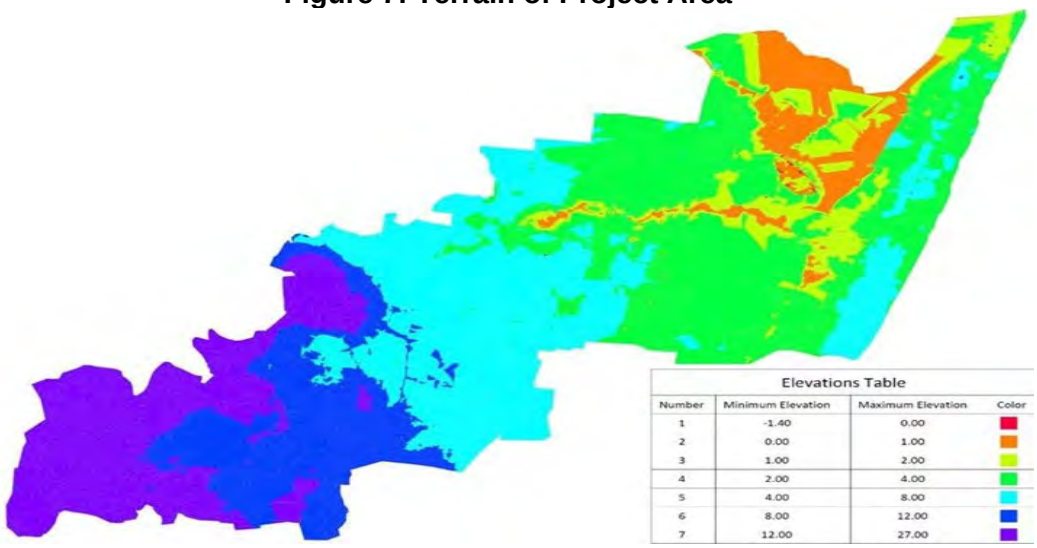
62. **Ocular inspection.** Several visits to the project sites and field monitoring surveys were made during the IEE preparation. The purpose of the inspection is to assess the existing environment (physical, biological, and socioeconomic) and gather information concerning the proposed sites and scale of the proposed project. A separate socioeconomic study was conducted to determine demographic information, existing service levels, stakeholder needs, and priorities.

## B. Physical Environmental Component

### 1. Topography of the Project Area

63. The Kosasthalaiyar basin is situated in the northern part of GCC, from latitudes 13$^{o}$05’40” to 13$^{o}$12’50” and Longitudes from 80$^{o}$08’20” to 80$^{o}$19’20”. Located on the coromandel coast of Bay of Bengal, the project area is characterized by flat terrain and sloping gently from west to east direction, towards Bay of Bengal. The elevation ranges between 0.27 m below mean sea level (msl) to + 27 m above mean sea level. msl. Elevation map is shown in the Figure 7.

**Figure 7: Terrain of Project Area**

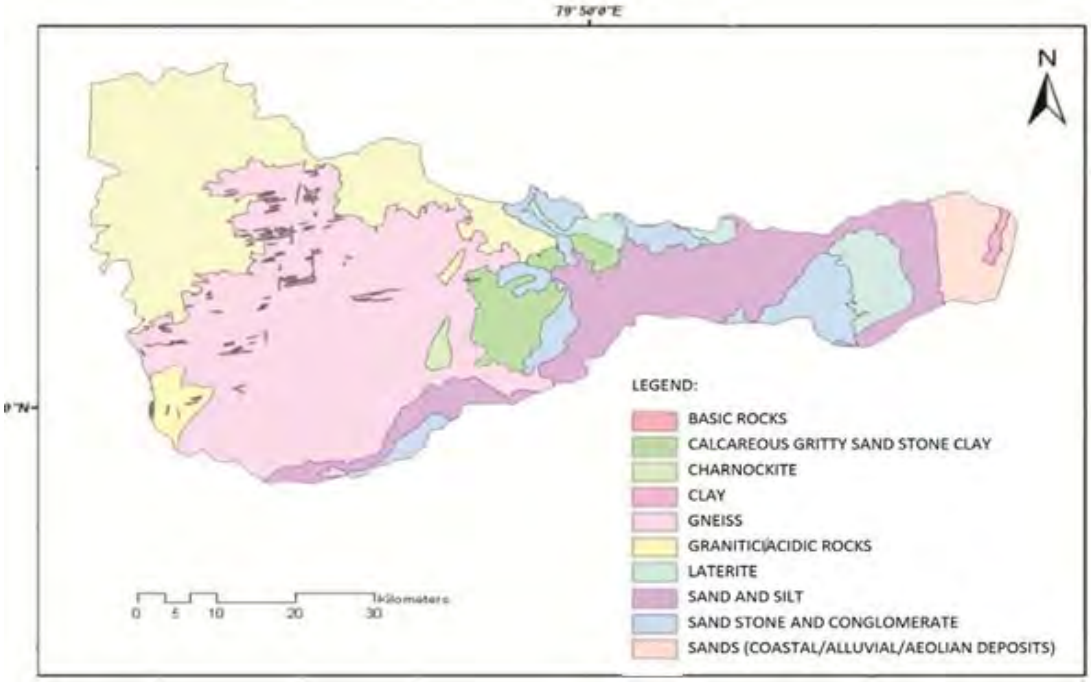



## 2. Geology and Soils

64. The Kosasthalaiyar River basin has varied geology. The western part is underlain by hard crystalline rocks (Precambrian) while the eastern part contains sedimentary rocks, alluvium, and Laterite. Numerous dolerite dyke is traversing in the western part of the study area. Laterite rocks are present in the northeastern portion, while calcareous gritty sandstone and clay are present in the central and eastern portion, Alluvium in the predominant formation along the river course.

65. Sand and clay are predominant within the project area. Standard penetration tests were conducted at proposed pumping station locations to determine the safe bearing capacity of the soil. Safe bearing capacity was determined as 10.36 T/$m^2$ at Kargil Nagar pumping station and 12.86 T/$m^2$ at Eranavur pumping station. Trial pits samples were collected at proposed storm water drain alignments to determine the soil properties such as Natural moisture content, Specific gravity etc. Specific gravity was found in the range of 2.35 to 2.66. Natural moisture content in the soil was found in the range of 17 to 40%.

**Figure 8: Geology of the Kosasthalaiyar Basin**




### 3. Hydrogeology

66. The project area is underlain by both porous and fissured formations. The important aquifer systems are constituted by i) unconsolidated & semi-consolidated formations and ii) weathered fissured and fractured crystalline rocks. The porous formations in the project area include sandstones and clays of Jurassic age (Upper Gondwana), marine sediments of Cretaceous age, Sandstones of Tertiary age and Recent alluvial formations. Groundwater occurs under phreatic to semi-confined conditions in the inter-granular pore spaces in sands and sandstones and the bedding planes and thin fractures in shales. Kosasthalaiyar riverbed is one of the major sources of water supply to urban areas of Chennai city and to the industrial units. The thickness of weathered zone is in the range of 2 to 12 m.

### 4. Climate

67. Chennai city has a tropical wet and dry climate. Chennai city lies on the thermal equator and is also coastal, which prevents extreme variation in seasonal temperature. For most of the year, the weather is hot and humid. The hottest part of the year is late May and early June with maximum temperatures around 38°C to 42°C. The coolest part of the year is January, with minimum temperatures around 18°C to 20°C.

### 5. Rainfall

68. The Chennai city gets most of its seasonal rainfall from the north-east monsoon, from mid-September to mid-December. Most of the precipitation occurs in the form of one or two cyclones caused due to depressions in Bay of Bengal. The southwest monsoon rainfall is highly erratic and summer rains are negligible. The average annual rainfall is 1200 mm. Annual, maximum daily rainfall and rainfall intensity from 1971-2016 is presented in Table 15. The maximum amount of

monthly rainfall (1104.2 mm) occurred in November 2015 and maximum amount of daily rainfall (320 mm) occurred on 2 December 2015.

**Table 15: Rainfall Data**

| Year | Rainfall in mm/hour | | | | | | | | | | | | Max One day Rainfall | Total Annual Rainfall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | July | Aug | Sep | Oct | Nov | Dec | | |
| 1971 | 23 | 0 | 56 | 18 | 13 | 30 | 74 | 49 | 44 | 501 | 307 | 109 | 230.5 | 1224.5 |
| 1972 | 36 | 0 | 0 | 0 | 82 | 53 | 92 | 52 | 121 | 445 | 175 | 410 | 138 | 1465.4 |
| 1973 | 0 | 0 | 0 | 0 | 2 | 18 | 29 | 219 | 71 | 205 | 155 | 272 | 92.8 | 971.8 |
| 1974 | 22 | 0 | 0 | 0 | 35 | 137 | 106 | 140 | 148 | 106 | 230 | 2 | 79.2 | 926.2 |
| 1975 | 0 | 0 | 0 | 0 | 0 | 53 | 163 | 332 | 200 | 337 | 539 | 0 | 160 | 1623.4 |
| 1976 | 0 | 0 | 0 | 0 | 0 | 114 | 168 | 246 | 51 | 424 | 841 | 33 | 359 | 1877 |
| 1977 | 3 | 0 | 0 | 0 | 7 | 107 | 6 | 170 | 143 | 525 | 615 | 13 | 134.3 | 1588.3 |
| 1978 | 1 | 6 | 0 | 0 | 0 | 38 | 177 | 81 | 239 | 108 | 302 | 725 | 189.3 | 1676.7 |
| 1979 | 6 | 0 | 12 | 0 | 112 | 4 | 77 | 64 | 167 | 182 | 621 | 126 | 112.2 | 1371.1 |
| 1980 | 0 | 0 | 0 | 0 | 0 | 24 | 172 | 169 | 39 | 127 | 609 | 196 | 216.6 | 1336 |
| 1981 | 33 | 0 | 0 | 0 | 40 | 54 | 153 | 87 | 192 | 295 | 103 | 144 | 92.3 | 1101.7 |
| 1982 | 7 | 0 | 0 | 7 | 2 | 111 | 85 | 148 | 121 | 176 | 252 | 13 | 144.5 | 922 |
| 1983 | 0 | 0 | 0 | 0 | 0 | 8 | 123 | 342 | 244 | 264 | 80 | 410 | 235.5 | 1470.8 |
| 1984 | 37 | 386 | 0 | 0 | 0 | 55 | 121 | 33 | 240 | 111 | 567 | 126 | 258.4 | 1676.4 |
| 1985 | 84 | 0 | 0 | 37 | 11 | 53 | 170 | 78 | 111 | 108 | 625 | 108 | 146.6 | 1385 |
| 1986 | 195 | 69 | 0 | 0 | 0 | 54 | 0 | 0 | 53 | 275 | 130 | 69 | 91 | 844.2 |
| 1987 | 12 | 0 | 38 | 16 | 0 | 54 | 21 | 119 | 49 | 0 | 0 | 218 | 64 | 527 |
| 1988 | 0 | 0 | 0 | 23 | 17 | 13 | 56 | 181 | 91 | 55 | 419 | 158 | 164 | 1013 |
| 1989 | 0 | 0 | 0 | 0 | 10 | 39 | 67 | 27 | 99 | 59 | 382 | 143 | 94 | 826 |
| 1990 | 5 | 11 | 9 | 0 | 265 | 70 | 98 | 73 | 143 | 458 | 330 | 66 | 147 | 1528.2 |
| 1991 | 17 | 0 | 0 | 0 | 0 | 276 | 80 | 76 | 137 | 402 | 698 | 2 | 228 | 1688 |
| 1992 | 0 | 0 | 0 | 0 | 0 | 0 | 72 | 85 | 129 | 75 | 164 | 161 | 92 | 695 |
| 1993 | 0 | 0 | 0 | 0 | 48 | 31 | 59 | 185 | 47 | 326 | 344 | 263 | 100 | 1303.4 |
| 1994 | 5 | 13 | 0 | 0 | 32 | 7 | 70 | 120 | 63 | 503 | 449 | 345 | 275 | 1607.2 |
| 1995 | 92 | 0 | 12 | 0 | 235 | 13 | 88 | 160 | 254 | 311 | 178 | 0 | 121 | 1343.4 |
| 1996 | 0 | 0 | 0 | 10 | 5 | 688 | 32 | 104 | 207 | 387 | 363 | 401 | 330 | 2196.6 |
| 1997 | 52 | 0 | 0 | 0 | 0 | 57 | 8 | 104 | 383 | 452 | 1442 | 471 | 277 | 2969 |
| 1998 | 0 | 0 | 0 | 0 | 10 | 13 | 69 | 75 | 53 | 220 | 377 | 148 | 130 | 964.5 |
| 1999 | 0 | 0 | 0 | 4 | 36 | 82 | 4 | 89 | 88 | 191 | 203 | 15 | 62 | 712 |
| 2000 | 10 | 0 | 0 | 69 | 12 | 24 | 88 | 53 | 66 | 428 | 351 | 261 | 135 | 1362 |
| 2001 | 10 | 0 | 0 | 69 | 48 | 24 | 88 | 35 | 70 | 427 | 104 | 0 | 135 | 874.5 |
| 2002 | 0 | 0 | 0 | 0 | 0 | 29 | 124 | 131 | 117 | 279 | 132 | 18 | 67 | 875 |
| 2003 | 0 | 0 | 4 | 3 | 0 | 14 | 104 | 101 | 117 | 174 | 69 | 71 | 78 | 655.9 |
| 2004 | 19 | 0 | 0 | 0 | 243 | 45 | 31 | 26 | 213 | 266 | 323 | 2 | 129 | 1168.4 |
| 2005 | 0 | 0 | 0 | 93 | 26 | 36 | 87 | 131 | 196 | 756 | 579 | 480 | 241 | 2383 |
| 2006 | 0 | 0 | 4 | 41 | 0 | 130 | 44 | 126 | 149 | 555 | 263 | 7 | 142 | 1319 |
| 2007 | 0 | 12 | 0 | 0 | 5 | 77 | 248 | 337 | 50 | 235 | 85 | 317 | 157 | 1366 |
| 2008 | 75 | 5 | 152 | 0 | 0 | 127 | 83 | 158 | 149 | 357 | 553 | 0 | 148 | 1659 |
| 2009 | 15 | 0 | 0 | 0 | 0 | 36 | 5 | 17 | 96 | 0 | 523 | 207 | 145 | 899.1 |
| 2010 | 0 | 0 | 0 | 0 | 251 | 110 | 244 | 286 | 84 | 161 | 211 | 240 | 143 | 1586.2 |
| 2011 | 1 | 67 | 0 | 54 | 4 | 77 | 72 | 249 | 214 | 229 | 434 | 108 | 90 | 1508.4 |
| 2012 | 16 | 0 | 0 | 0 | 0 | 39 | 83 | 64 | 150 | 324 | 86 | 154 | 95 | 915.7 |
| 2013 | 0 | 42 | 17 | 0 | 1 | 99 | 169 | 174 | 165 | 235 | 89 | 36 | 65 | 1025.8 |

| Year | Rainfall in mm/hour | | | | | | | | | | | | Max One day Rainfall | Total Annual Rainfall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | July | Aug | Sep | Oct | Nov | Dec | | |
| 2014 | **0** | 4 | **0** | **0** | 16 | 74 | 81 | 111 | 80 | **314** | 206 | 165 | 91 | 1049.8 |
| 2015 | 4 | **0** | **0** | 36 | 14 | 47 | 178 | 202 | 74 | 161 | **1104** | 441 | 320 | 2261.6 |
| 2016 | **0** | **0** | **0** | **0** | 191 | 115 | 25 | 16 | **256** | 12 | 39 | 218 | 107 | 872.9 |

Source: IMD, Chennai Max Rainfall Min Rainfall

## 6. Air Quality

69. The objective of the baseline air quality study was to assess the existing air quality of the project area. This will also be useful for assessing the conformity to standards of the ambient air quality during the construction and operation of the proposed project. The majority of the study area represents residential, mixed residential, industrial, water bodies and commercial land use.

**Figure 9: Location of Air Sampling Points**


70. Based on the land-use pattern, 24 –hours Ambient Air Quality (AAQ) monitoring has been conducted at 5 locations and analyzed for the key parameters including $SO_2$, $NO_2$, $PM_{10}$, $PM_{2.5}$, O3, CO, and $NH_3$. AAQ Sampling locations are shown in Figure 9. The outcome of the analysis is presented in Table 16.

71. It was observed that the $PM_{10}$ was in the range between 61 to 112 µg/m$^3$. The observed values exceed the 24 hours limit of 100 µg/m$^3$ in three locations namely AAQ-1, AAQ-2 and AAQ-

3. The high concentration of $PM_{10}$ was due to the road dust generated due to the hectic vehicular traffic in Manali High Road and Tiruvotriyur-Ponneri Road. $PM_{2.5}$ was found to be within 60 µg/$m^3$ for 24 hours monitoring at all locations. Similarly, the $SO_2$ and $NO_2$ concentrations were observed to be within the limits of 80 µg/$m^3$.

**Table 16: Air Sampling Locations**

| S. No | Location of Sampling points | Parameters covered | Date of Sampling |
|---|---|---|---|
| 1 | (AAQ-1) Manali high road - Kalaignarnagar, Tiruvoittyur | $SO_2$, $NO_2$, $PM_{10}$, $PM_{2.5}$, Ozone, CO, Ammonia, Lead | 22nd and 23rd April, 2019 for 24 Hours monitoring |
| 2 | (AAQ-2) St. Joseph's Matriculation Higher Secondary School, Kathivakkam | | |
| 3 | (AAQ-3) Near Zuari Cement Grinding Unit – Athipattu | | |
| 4 | (AAQ-4) Near Ashok Leyland Technical Centre – Vallur | | |
| 5 | (AAQ-5) Manali New Town | | |

**Table 17: Air sampling Test Results (Apr 2019)**

| S.No. | Parameter | Unit | Averaging Period | NAAQ standard Values µg/$m^3$ | AAQ-1 | AAQ-2 | AAQ-3 | AAQ-4 | AAQ-5 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | $PM_{10}$ | µg/$m^3$ | 24 hours | 100 | 112 | 103 | 107 | 61 | 73 |
| 2 | $PM_{2.5}$ | µg/$m^3$ | 24 hours | 60 | 57 | 42 | 42 | 19 | 27 |
| 3 | $SO_2$ | µg/$m^3$ | 24 hours | 80 | 14 | 11 | 17 | 9 | 11 |
| 4 | $NO_2$ | µg/$m^3$ | 24 hours | 80 | 30 | 27 | 23 | 14 | 19 |

Source: Draft DPR for Eco-restoration of Ennore Creek prepared by Voyants Solutions Pvt Ltd. 2019.
BDL: Below Detection Limit, DL: Detection Limit

## 7. Noise Quality

72. The main objective of noise monitoring in the study area is to establish the baseline noise levels and to assess the impact of the total noise expected to be generated during the construction and operation of the project. Noise monitoring locations are shown in Figure 10. Ambient noise was measured at 5 locations for 24 hours duration on 10 June 2019 to determine the ambient noise quality around the project area. The results are shown in Table 18. From the inference, it is evident that the ambient noise level around the study area is well within the stipulated limit as per the Noise Pollution (Regulation and Control) Rules 2000 as well as World Bank Group's EHS Noise Level Guidelines.

**Figure 10: Noise Monitoring Locations**

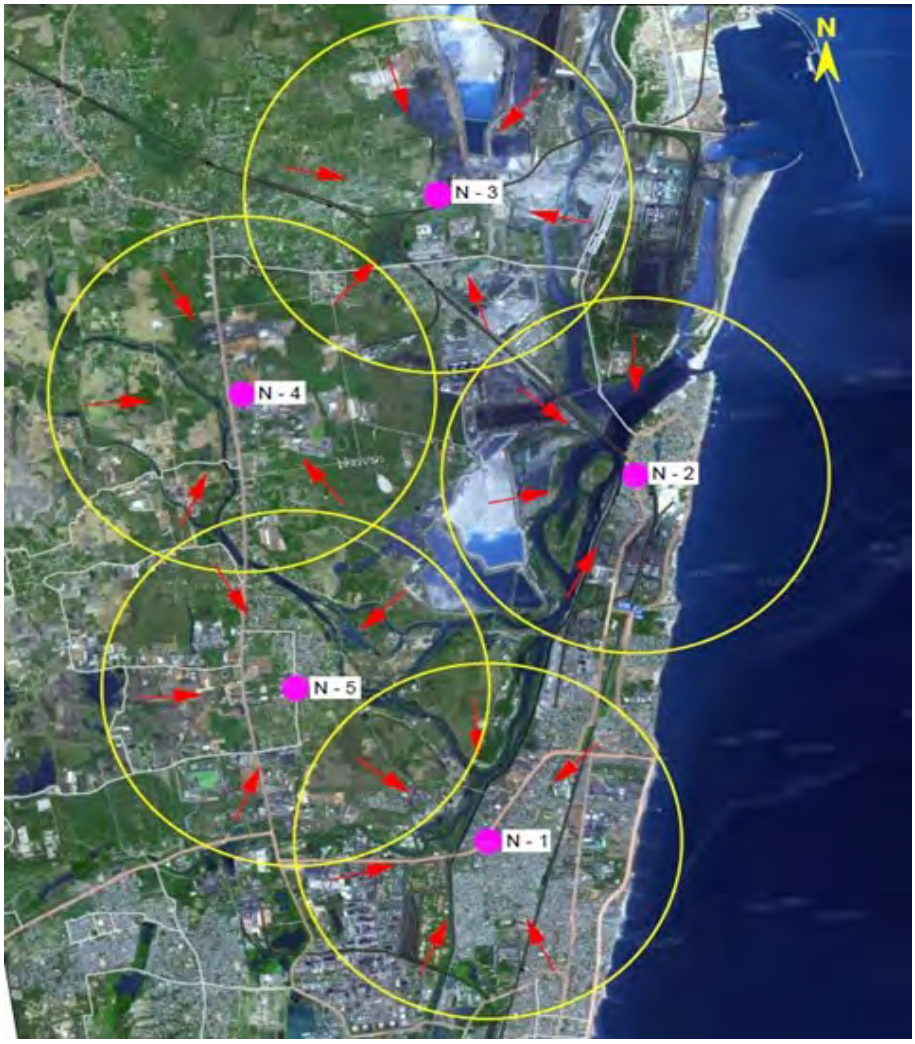



**Table 18: Ambient Noise Monitoring (June 2019) – Inference**

| Sl No. | Location | Type of Area | Test Results (dB(A) Leq) | | Permissible Limits (Leq dB(A) | |
|---|---|---|---|---|---|---|
| | | | Day time | Night Time | Day Time (07.00 -22.00) | Night Time (22.00 – 07.00) |
| 1 | Location 1 - Near Nivedha School, Tiruvottriyur | Silence Zone | 46.2 | 39 | 50 | 40 |
| 2 | Location 2 - Near St. Joseph's School, Kathivakkam | Silence Zone | 47.6 | 39.2 | 50 | 40 |
| 3 | Location 3 - Near Zuari Cement, Athipattu | Industrial Zone | 64.3 | 56.4 | 75 | 70 |
| 4 | Location 4 - Near Ponneri-Thiruvottriyur Road, Vallur | Commercial Area | 58.5 | 54.1 | 65 | 55 |
| 5 | Location 5 - Near Ayyakovil Street, Manali | Commercial Area | 55.6 | 53.4 | 65 | 55 |

Source: Draft DPR for Eco-restoration of Ennore Creek prepared by Voyants Solutions Pvt Ltd.,2019

## 8. Sediment/Silt Analysis of Surplus Canals/ Drains

73. It is proposed desilt the surplus canals of accumulated bottom silt where required to maintain the hydraulic capacity. Sediment analysis was conducted to assess the characteristic and disposal measure of the excavated sediments. Sediment sampling locations are shown in Figure 11. The test results are given in Table 19. An estimated 100,000 $m^3$ of sediment/silt is likely to be generated from the proposed works. Samples were collected from various points (Figure 11) and analysed in the laboratory for various parameters.

**Figure 11: Locations of Sediment Samples**


74. Sediment samples are analysed for 13 parameters such as Colour, Texture, Phosphate ($PO_4$), Sodium (Na), Nitrate, Iron (Fe), Chromium (Cr), Manganese (Mn), Lead (Pb), Zinc (Zn), Copper (Cu), Nickel (Ni), Cobalt (Co). From the test results, it is observed that heavy metals such as Lead (Pb), Chromium (Cr) are found below the detectable limit. Test results indicate that there are no hazardous elements present beyond the prescribed limits as per Hazardous Wastes (Management, Handling, and Transboundary Movement) Rules, 2008 - Central Pollution Control Board (CPCB). Test Results of Sediment Analysis in surplus canals and major lakes are enclosed in Appendix 9.

**Table 19: Sediment Sampling Test Results (Jan 2018)**

| Sl.no | Sampling locations | Parameters | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Colour | Texture | Phosphate ($PO_4$) | Sodium (Na) | Nitrate | Iron (Fe) | Manganese (Mn) | Zinc (Zn) | Copper (Cu) | Nickel (Ni) | Cobalt (Co) |
| | | - | - | mg/Kg | mg/Kg | mg/Kg | % | mg/Kg | mg/Kg | mg/Kg | mg/Kg | mg/Kg |
| 1 | Ambattur Surplus | Black & Brown | Clay | 388 | 267 | 866 | 1.53 | 209.84 | 42.9 | 33.7 | 44.71 | 13.15 |
| 2 | Korattur Surplus | Grey | Clay | 311 | 498 | 382 | 2.09 | 205.09 | 25.5 | 14.46 | 31.34 | 17.99 |
| 3 | Puzhal Surplus - 1 | Brown | Clay | 333 | 784 | 288 | 2.09 | 218.46 | 20.28 | 12.37 | 30.48 | 16.11 |
| 4 | Puzhal Surplus - 2 | Brown | Clay | 850 | 747 | 248 | 2.08 | 124.47 | 47.94 | 15.97 | 35.62 | 14.42 |
| 5 | Puzhal Surplus - 3 | Pale Grey | Loam | 51.6 | 1963 | 342 | 330.2 | 351.38 | 30.75 | 5.5 | 20.69 | 16.06 |
| 6 | Ambattur Lake - 1 | Dark Brown | Clay | 173 | 239 | 118 | 1.62 | 314 | 53.4 | 42.94 | 26.8 | 7.37 |
| 7 | Ambattur Lake - 2 | Brown | Clay | 164 | 381 | 162 | 1.47 | 267 | 39.7 | 49.32 | 32.1 | 10.4 |
| 8 | Ambattur Lake - 3 | Brown | Clay | 66.5 | 185 | 84.6 | 1.32 | 295 | 30.72 | 41.9 | 35.7 | 6.35 |
| 9 | Ambattur Lake - 4 | Brown | Clay | 81.8 | 829 | 174 | 1.39 | 239 | 37.6 | 44.5 | 31.8 | 10.5 |
| 10 | Korattur Lake - 1 | Brown | Clay | 120 | 353 | 154 | 1.84 | 198 | 54.9 | 19.4 | 29.7 | 16.2 |
| 11 | Korattur Lake - 2 | Brown | Clay | 74.9 | 266 | 98.4 | 1.92 | 254 | 42.9 | 16.4 | 22.47 | 19.1 |
| 12 | Korattur Lake - 3 | Brown | Clay | 136 | 253 | 106 | 1.61 | 164 | 36.3 | 21.1 | 26.4 | 15.7 |
| 13 | Korattur Lake - 4 | Brown | Clay | 23.3 | 676 | 148 | 1.47 | 161 | 61.2 | 19.7 | 33.9 | 11.7 |
| 14 | Retteri Lake - 1 | Brown | Clay | 85.3 | 292 | 114 | 1.46 | 264 | 44.32 | 37.8 | 42.4 | 12.9 |
| 15 | Retteri Lake - 2 | Brown | Clay | 124 | 502 | 146 | 1.27 | 324 | 52.6 | 31.6 | 42.4 | 9.46 |
| 16 | Retteri Lake - 3 | Brown | Clay | 143 | 184 | 92.4 | 1.36 | 298 | 45.32 | 25.8 | 39.1 | 10.9 |
| 17 | Retteri Lake - 4 | Brown | Clay | 814 | 272 | 124 | 1.47 | 198 | 51.2 | 32.4 | 32.5 | 8.51 |

| Sl.no | Sampling locations | Parameters | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Colour** | **Texture** | **Phosphate ($PO_4$)** | **Sodium (Na)** | **Nitrate** | **Iron (Fe)** | **Manganese (Mn)** | **Zinc (Zn)** | **Copper (Cu)** | **Nickel (Ni)** | **Cobalt (Co)** |
| | | **-** | **-** | **mg/Kg** | **mg/Kg** | **mg/Kg** | **%** | **mg/Kg** | **mg/Kg** | **mg/Kg** | **mg/Kg** | **mg/Kg** |
| | Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2008 (Schedule II (See rule 3(I)) | - | - | - | - | 20000 (class C) | - | 5000 (class B) | 20000 (class C) | 5000 (class B) | 5000 (class B) | 5000 (class B) |

## 9. Ground Water Quality

75. The purpose of this study is to assess the groundwater quality characteristics in the project area. The groundwater samples were collected at 5 locations covering the study area. The following table illustrates the justification behind choosing the sampling locations.

**Table 20: Ground Water Sampling Locations**

| Sl No. | Location | Justification for Sampling Locations |
|---|---|---|
| 1 | Ambattur (Hand Pump) | Due to Sullage / Sewage / effluent discharge from the cluster of industries |
| 2 | Pattaravakkam | Due to Sullage / Sewage / effluent discharge from the cluster of industries |
| 3 | Retteri | Due to the densely populated residential area and to assess contamination if any |
| 4 | Manali | Due to fly ash and industrial effluent discharge from Thermal Power Plants and Fertilizer Industries |
| 5 | Buckingham Canal near Ennore | Due to fly ash and industrial effluent discharge from Thermal Power Plants and Fertilizer Industries |

**Figure 12: Locations of Ground Water Samples**


76. Summary of Groundwater analysis is presented in Table 21. The test results are compared with the drinking water standard (IS 10500) for the parameters viz pH, Total dissolved solids, Sulphate ($SO_4$), Chloride ($Cl^-$), Iron (Fe) and Lead (Pb). Groundwater sample collected from Ambattur Hand Pump indicates a high concentration of TDS (1,064mg/l) and Chloride (255 mg/l). Both the parameters exceed the stipulated limits of 500 mg/l and 250 mg/l respectively. In Pattaravakkam, the groundwater samples indicate high concentration of TDS (1812mg/l), Chloride (570 mg//l) and Sulphate (387mg/l) Groundwater sample collected from Retteri shows, high concentration of TDS (1,318mg/l), Chloride (350mg/l) and Sulphate (230 mg/l). Groundwater quality at Manali indicate high concentration of TDS (2,648 mg/l), Chloride (716 mg/l) and Sulphate (207 mg/l). Groundwater sample collected at Ennore shows a high concentration of TDS (1,098 mg/l). Based on the analysis outcome, it is evident that the groundwater should be treated before consumption.

**Table 21: Ground Water Samples – Test Results (Jan 2018)**

| S.No. | Parameters | Units | Ground Water Sample Location | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Ambattur (Hand pump) | Pattaravakkam | Retteri | Manali | Ennore | Acceptable Limit IS 10500:2012 |
| 1 | pH @ 25°C | - | 6.8 | 7.7 | 7.3 | 6.7 | 7.2 | 6.5-8.5 |
| 2 | Total Dissolved Solids | mg/l | 1064 | 1812 | 1318 | 2648 | 1098 | 500 |
| 3 | Iron as Fe | mg/l | 0.05 | 0.08 | 0.06 | 0.09 | 0.05 | 0.3 |
| 4 | Chloride as $Cl^-$ | mg/l | 255 | 570 | 350 | 716 | 250 | 250 |
| 5 | Fluoride as F | mg/l | 0.2 | 0.21 | 0.24 | 0.21 | 0.23 | 1 |
| 6 | Nitrate as $NO_3$ | mg/l | 32.4 | 0.24 | 17.7 | 194 | 76.8 | 45 |
| 7 | Sulphate as $SO_4$ | mg/l | 104 | 387 | 230 | 207 | 129 | 200 |

## 10. Surface Water Quality

77. The purpose of this study is to assess the surface water quality characteristics in the project area. Out of eight major lakes in the project area, four lakes (Ambattur, Korattur, Retteri, and Puzhal) are located on upstream of the Kosasthalaiyar Basin. The Kosasthalaiyar River in the project area is a seasonal river, at the time of sampling it was completely dry and hence water samples has not been collected.

(i) **Ambattur Lake** is a rain-fed reservoir, which reaches maximum levels during the monsoon seasons. The catchment area of the lake is 2.06 $km^2$. In November 2008, the lake experienced high water level, causing flood and damages to the encroached settlements, which was then removed by the GCC. It also caters to the drinking water needs of the Chennai city after Poondi and Chembarambakkam Lake. Ambattur Lake is one of a chain of three water bodies, including the Korattur Lake and the Retteri / Madhavaram Lake, where surplus water from one lake is transported to another.

(ii) **Korattur Lake**, (also known as Vembu Pasumai Thittu), spread over 400 ha (4 $km^2$) and It is located to the north of the Chennai–Arakkonam railway line. The catchment area is 8.32 $km^2$. It is one of the largest lakes in the western part of the Chennai city. The water from the lake had been supplied to Chennai residents for a brief period when there was a shortage in the late 1970s. However, over the years, the lake has been contaminated with sewage and industrial effluents from surrounding areas such as Pattaravakkam, Athipet and Ambattur Industrial estate.

(iii) **Retteri Lake** is located at Kolathur area in Chennai. The lake has surface area of 700 acres (280 ha). It has a catchment area of 17.07 $km^2$. This lake was neglected for several decades; it gets inflows from Red Hills reservoir and Korattur Lake. The Water Resources Department (WRD) has decided to improve Rettai Eri along with water bodies in Ambattur and Korattur area.

(iv) **Puzhal Lake**, also known as the **Red Hills Lake**, is located in Red Hills, Chennai. It lies in Thiruvallur district of Tamil Nadu state. It is one of the rain-fed reservoirs from where water is drawn for supply to Chennai City. The reservoir was originally a small tank with a capacity of 500 million cubic feet (mcft) and two masonry weirs, built using locally available laterite stones, then functioned as surplus weirs to release excess water from the water body. In 1997, the storage capacity of the water reservoir was increased to 3,300 mcft and the depth to 21.20 ft to cater to the drinking water needs of Chennai and to store Krishna River water received from Andhra Pradesh through Poondi Reservoir and the Sholavaram Tank.

78. Surface water samples has been collected from the water bodies as listed in the Table 22 and analyzed for its physic chemical characteristics. The results from the analysis are furnished in Table 23. The results were compared with the Schedule VI - General Standards for Discharge of Environmental Pollutants - Part A by CPCB.

79. From the test results, it was observed that the surface water collected from Ambattur, Korattur and Retteri lakes comply with IS 2296 – Class C – Drinking water with conventional treatment followed by disinfection. The water sample collected from Thanikachalam drain has high content of BOD, Iron (Fe), Sulphide (S). Water sample from Puzhal Surplus has high content of BOD, Iron (Fe), Sulphide, Manganese (Mn). Water sample collected from Harikrishnapuram pond has high content of Total dissolved solids, Iron (Fe), Chloride (Cl), BOD, Sulphide (S), Manganese (Mn). Water sample from Kosasthalaiyar Water Shed has High content of TDS, Iron (Fe), Chloride (Cl), and Manganese (Mn). Water sample from Buckingham Canal near Ennore has very high content of TDS, Iron (Fe), Chloride (Cl), Sulphate ($SO_4$).

80. **Inference:** Ambattur, Korattur and Retteri surface water can be used for drinking water purposes with proper treatment as the test results are within prescribed limits. In Thanikachalam drain, due to sullage discharge, the BOD concentration was observed to be high. Similarly, due to industrial effluent discharge from thermal power plants and fertilizer industries located closed to Ennore, high content of TDS, Iron (Fe), Chloride (Cl), Manganese (Mn) are observed in Kosasthalaiyar Water Shed and Buckingham Canal. Test Results of Surface Water Quality is enclosed in Appendix 9.

**Table 22: Surface Water Sampling Locations**

| Sl No. | Location | Reference |
|---|---|---|
| 1 | Ambattur Lake | AMB-SURF-001 to AMB-SURF-004 |
| 2 | Korattur Lake | KOR-SURF-001 to KOR-SURF-004 |
| 3 | Retteri Lake | RET-SURF-001 to RET-SURF-004 |
| 4 | Thanikachalam Drain | RET-SURF-001 |
| 5 | Puzhal Surplus – 1 | PUZL-SURF-001 |
| 6 | Puzhal Surplus – 2 | PUZL-SURF-002 |
| 7 | Kosasthalaiyar watershed | KOS-SURF-001 |
| 8 | Buckingham Canal near Ennore | ENN-SURF-001 |
| 9 | Surapet Lake | SURA-SURF-001 |
| 10 | Harikrishnapuram Pond | HAR-SURF-001 |

**Figure 13: Surface water Quality Locations in Google maps**


**Table 23: Surface Water Test Results (Jan 2018)**

| Sl.no | Location | pH @ 25°C | Iron | Chloride | Fluoride | Nitrate | Sulphate | 3 days BOD @ 27°C | Oil & Grease |
|---|---|---|---|---|---|---|---|---|---|
| | | - | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| 1 | Surapet Lake | 7.8 | 0.19 | 175 | 0.26 | 2.3 | 46.9 | <2 | <2 |
| 2 | Thanikachalam Drain | 6.9 | 5.6 | 380 | 0.21 | 0.56 | 91.4 | 80 | <2 |
| 3 | Puzhal Surplus 1 | 6.9 | 2.4 | 250 | 0.23 | 1.9 | 103 | 40 | <2 |
| 4 | Puzhal Surplus 2 | 7.3 | 1.6 | 425 | 0.26 | 24.1 | 63.3 | 6 | <2 |
| 5 | Harikrishnapuram Pond | 7.1 | 14.7 | 1000 | 0.28 | 2.8 | 43.3 | 120 | <2 |
| 6 | Kosasthalaiyar Watershed | 7.7 | 0.11 | 1600 | 0.2 | 0.81 | 339 | <2 | <2 |
| 7 | Buckingham Canal near Ennore Creek | 6.8 | 1.8 | 15828 | 0.22 | 7.5 | 2165 | 8 | <2 |
| 8 | Ambattur Lake 1 | 7.5 | 0.48 | 181 | 0.26 | BDL | 92.9 | <2 | <2 |
| 9 | Ambattur Lake 2 | 7.5 | 0.42 | 177 | 0.26 | | 97.4 | <2 | <2 |
| 10 | Ambattur Lake 3 | 7.5 | 0.38 | 175 | 0.27 | 0.4 | 91.5 | <2 | <2 |
| 11 | Ambattur Lake 4 | 7.4 | 0.49 | 184 | 0.24 | 2.7 | 93.9 | <2 | <2 |
| 12 | Korattur Lake 1 | 7.4 | 0.54 | 249 | 0.31 | 0.16 | 109 | <2 | <2 |
| 13 | Korattur Lake 2 | 7.4 | 0.51 | 237 | 0.26 | BDL | 101 | 6 | <2 |
| 14 | Korattur Lake 3 | 7.5 | 0.49 | 239 | 0.24 | BDL | 102 | <2 | <2 |
| 15 | Korattur Lake 4 | 7.5 | 0.47 | 239 | 0.26 | 0.56 | 98.8 | 7 | <2 |

| Sl.no | Location | pH @ 25°C | Iron | Chloride | Fluoride | Nitrate | Sulphate | 3 days BOD @ 27°C | Oil & Grease |
|---|---|---|---|---|---|---|---|---|---|
| | | - | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| 16 | Retteri Lake 1 | 7.5 | 0.5 | 223 | 0.24 | 3.1 | 99.5 | <2 | <2 |
| 17 | Retteri Lake 2 | 7.6 | 0.39 | 181 | 0.21 | BDL | 90.4 | <2 | <2 |
| 18 | Retteri Lake 3 | 7.6 | 0.36 | 200 | 0.24 | BDL | 91.8 | <2 | <2 |
| 19 | Retteri Lake 4 | 7.4 | 0.62 | 124 | 0.26 | 0.11 | 104 | 7 | <2 |

*Acceptable Limit as per IS 2296:1962 – Class C (Surface Water as drinking water source)

**Table 24: Water Quality Standards in India (source IS 2296:1992)**

| Characteristics | Designated best use# | | | | |
|---|---|---|---|---|---|
| | Class A | Class B | Class C | Class D | Class E |
| Dissolved Oxygen (DO)mg/l, min | 6 | 5 | 4 | 4 | - |
| Biochemical Oxygen demand (BOD) mg/l, max | 2 | 3 | 3 | - | - |
| Total coliform organisms MPN/100ml, max | 50 | 500 | 5,000 | - | - |
| pH value | 6.5-8.5 | 6.5-8.5 | 6.0-9.0 | 6.5-8.5 | 6.0-8.5 |
| Colour, Hazen units, max. | 10 | 300 | 300 | - | - |
| Odour | Un-objectionable | | | - | - |
| Taste | Tasteless | - | - | - | - |
| Total dissolved solids, mg/l, max. | 500 | - | 1,500 | - | 2,100 |
| Total hardness (as $CaCO_3$), mg/l, max. | 200 | - | - | - | - |
| Calcium hardness (as $CaCO_3$), mg/l, max. | 200 | - | - | - | - |
| Magnesium hardness (as $CaCO_3$), mg/l, max. | 200 | - | - | - | - |
| Copper (as Cu), mg/l, max. | 1.5 | - | 1.5 | - | - |
| Iron (as Fe), mg/l, max. | 0.3 | - | 0.5 | - | - |
| Manganese (as Mn), mg/l, max. | 0.5 | - | - | - | - |
| Chlorides (as Cu), mg/l, max. | 250 | - | 600 | - | 600 |
| Sulphates (as $SO_4$), mg/l, max. | 400 | - | 400 | - | 1,000 |
| Nitrates (as $NO_3$), mg/l, max. | 20 | - | 50 | - | - |
| Fluorides (as F), mg/l, max. | 1.5 | 1.5 | 1.5 | - | - |
| Phenolic compounds (as $C_2H_5OH$), mg/l, max. | 0.002 | 0.005 | 0.005 | - | - |
| Mercury (as Hg), mg/l, max. | 0.001 | - | - | - | - |
| Cadmium (as Cd), mg/l, max. | 0.01 | - | 0.01 | - | - |
| Selenium (as Se), mg/l, max. | 0.01 | - | 0.05 | - | - |
| Arsenic (as As), mg/l, max. | 0.05 | 0.2 | 0.2 | - | - |
| Cyanide (as Pb), mg/l, max. | 0.05 | 0.05 | 0.05 | - | - |
| Lead (as Pb), mg/l, max. | 0.1 | - | 0.1 | - | - |
| Zinc (as Zn), mg/l, max. | 15 | - | 15 | - | - |
| Chromium (as $Cr^{6+}$), mg/l, max. | 0.05 | - | 0.05 | - | - |
| Anionic detergents (as MBAS), mg/l, max. | 0.2 | 1 | 1 | - | - |
| Barium (as Ba), mg/l, max. | 1 | - | - | - | - |
| Free Ammonia (as N), mg/l, max | - | - | - | 1.2 | - |
| Electrical conductivity, micromhos/cm, max | - | - | - | - | 2,250 |

| Characteristics | Designated best use# | | | | |
|---|---|---|---|---|---|
| | Class A | Class B | Class C | Class D | Class E |
| Sodium absorption ratio, max | - | - | - | - | 26 |
| Boron, mg/l, max | - | - | - | - | 2 |

*Source: CPCB*
*# Designated best use classification:*
*Class A: Drinking water source without conventional treatment but after disinfection*
*Class B: Outdoor bathing (organized)*
*Class C: Drinking water source after conventional treatment and disinfection*
*Class D: Propagation of wildlife and Fisheries*
*Class E: Irrigation, industrial cooling, controlled waste disposal*

## C. Biological Environment

81. To profile biological environmental of the project area, a walk-through survey was carried out in the project area, including of all the major water bodies, such as lakes, and the coastal zone. These walkthrough surveys were conducted in September (1st and last week) and October 2020 1st and 3rd week). The location of the major lakes in the project area is given in the Figure 14. The project area includes habitats such as the terrestrial ecosystem, the freshwater ecosystem, the urban terrain ecosystem and the fragmented scrub jungle ecosystem. The type of ecosystem, both the flora and fauna in the project area were estimated on the basis of visual observation, photo and video evidence. Secondary literature / published documents / reports available on all these habitats were reviewed. The findings of the floral the survey is given in the Table 25. Floral species recorded in the project area includes Macrophytes, Herbs/weeds/climbers, Shrubs and Trees.

82. **Flora.** Of the seven lakes surveyed, three lakes fall under the peri-urban limit (neither rural nor urban), the Ariyalur Lake, Kadapakkam Lake and the Sadayankuppam Lake. Four lakes, the Ambattur Lake, Korattur Lake, Retteri Lake, Madhavaram Periyathoppu fall under the urban limit, along all the four lakes the land use is dominated by residential and industrial. The water is clear and the macrophytes species diversity was more in Ariyalur Lake, Kadapakkam Lake and the Sadayankuppam Lake. Of the 73 floral species identified, 10 species are macrophytes, 35 species of herbs and climbers, 10 species of shrubs and 18 species of trees. Comparative Assessment of Floral species between the Lakes is presented in:

83. Table 26. The Ariyalur Lake and Kadapakkam Lake had the maximum species diversity (Table 27) and the Sadayankuppam Lake, though small in size had good vegetation cover, this lake is within 100 mts from the Kosasthalaiyar river and the tidal influence is observed within 80 mts from the lake. The presence of species like *Nelumbo nucifera, Nymphaea pubescens* and *Nymphaea nouchali* in all the three lakes indicate the water quality in good and can be used for drinking with minor treatment. It is also observed that none of the identified floral species are categorized as endangered species.

84. **Fauna.** Faunal species recorded include butterflies, fishes, amphibians, reptiles, birds and mammals. Detailed list of Fauna in the project area is attached in **Appendix 9.** The Ariyalur Lake, Kadapakkam Lake and Korattur Lake had good numbers of macro fauna compared to the other lakes, all the three lakes represented more than 54 species of birds of the 61 species recorded all together, which shows the availability of habitat and the food for these species. The enhancement of these lakes will still attract more flora and fauna to these regions. The conservation status of all the identified faunal species is listed in the:

85. **Table 28**, 3 species of butterflies and 7 species of snakes listed as Near Threatened and all the other species are not categorized under endangered species. The presence of the various faunal species indicates a healthy eco system in the project areas.

**Figure 14: Major Lakes in Project Area**

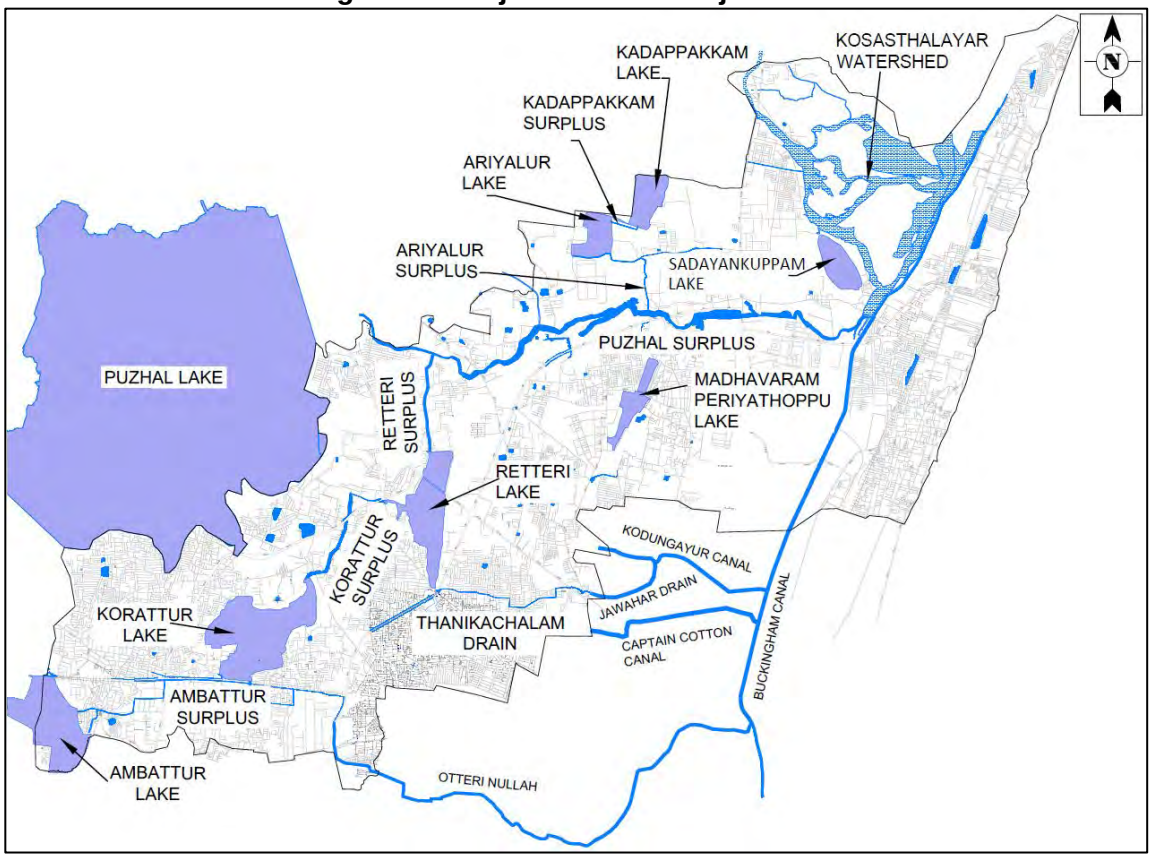



**Table 25: List of Floral Species in the Project area and their conservation status**

| S. N | Botanical Name | Habit | Common Name | Local Name | IUCN / Wildlife Protection Act 1972 - Status |
|---|---|---|---|---|---|
| 1 | *Abutilon indicum* | H | Indian Mallow | Paniyaratutti | LC |
| 2 | *Abrus precatorius* | C | Rosary Pea | Kundumani | LC |
| 3 | *Acalypha Indica* | H | Indian Acalypha | Kuppaimeni | LC |
| 4 | *Achyranthes aspera* | H/W | Prickly Chaff Flower | Nayuruvi | LC |
| 5 | *Alternanthera philoxeroides* | M | Alligator Weed | Ponnaganni | LC |
| 6 | *Albizia saman* | T | Rain Tree | Amaivagai | LC |
| 7 | *Aponogeton natans* | M | Floating Lace Plant | Kotti kizhangu | LC |
| 8 | *Azadirachta indica* | T | Neem | Vepamaram | LC |
| 9 | *Borassus flabellifer* | T | Toddy Palm | Panai maram | LC |
| 10 | *Brachiaria distachya* | H/W | Water Grass | Erumaipul | LC |

| S. N | Botanical Name | Habit | Common Name | Local Name | IUCN / Wildlife Protection Act 1972 - Status |
|---|---|---|---|---|---|
| 11 | *Cassia auriculata* | S | Mature Tea Tree | Avaram | LC |
| 12 | *Cassia occidentalis* | H | Senna | Payaverai | LC |
| 13 | *Cassia hirsuta* | H/W | Thagara Chedi | Thagara chedi | LC |
| 14 | *Calotropis gigantean* | S | Giant Milkweed | Erukkuchedi | LC |
| 15 | *Catharanthus roseus* | H | Rosy Periwinkle | Nithyakalyani | LC |
| 16 | *Chloris barbata* | H/W | Purple Finger Grass | Sevaragupul | LC |
| 17 | *Clitorea arborea* | C | Butterfly Pea | Sangu pushpam | NE |
| 18 | *Coccinia grandis* | C | Ivy Gourd | Kovaikai | LC |
| 19 | *Cynodon dactylon* | H | Aragampullu | Aragampullu | NE |
| 20 | *Cocos nucifera* | T | Coconut Palm | Tennimaram | LC |
| 21 | *Croton bonplandianum* | H | Ban Tulasi | Reilpoondu | LC |
| 22 | *Datura innoxia* | H/W | Trumpet Flower | Umathai | LC |
| 23 | *Delonix regia* | T | Flamboyant | Mayil kondrai | LC |
| 24 | *Dactyloctenium aegyptium* | H/W | Egyptiantoe grass | Mathangaipul | NE |
| 25 | *Eclipta prostrata* | H | False Daisy | Karasilangani | LC |
| 26 | *Eichornia crassipes* | AH | Water Hyacinth | Water hyacinth | LC |
| 27 | *Eichornia crassipes* | M | Water Hyacinth | Akasa tamarai | NE |
| 28 | *Euphorbia corrigioloides* | H | Centipede Plant | Pooran chedi | LC |
| 29 | *Ficus benghalensis* | T | Indian Banyan | Alamaram | LC |
| 30 | *Ficus racemosa* | T | Indian Fig Tree | Atathi | LC |
| 31 | *Ficus religiosa* | T | Bodhi Tree | Arasa Maram | LC |
| 32 | *Gloriosa superba* | H | Glory Lily | Chenkanta | LC |
| 33 | *Hibiscus rosa-sinensis* | S | Chembaruthi | " " | LC |
| 34 | *Hygrophila auriculata* | H | Marsh Barbel | Nirmulli | LC |
| 35 | *Ipomoea aquatica* | M | Water Morning Glory | Sarkaraivalli | LC |
| 36 | *Ipomoea carnea* | S/W | Morning Glori | Neyveli kaatamanakku | LC |
| 37 | *Jasminum angustifolium* | H | Wild Jasmine | Kaadumalli | LC |
| 38 | *Jatropha curcas* | S | Physic Nut | Kattamanakku | LC |
| 39 | *Jatropha gossypifolia* | S | Belly Ache Bush | Siria Amanakku | LC |
| 40 | *Lantana camara* | S/W | Wild Sage | Unni chedi | LC |
| 41 | *Lennea coromandelica* | T | Indian Ash Tree | Odyamaram | LC |
| 42 | *Malachra capitata* | H | Brazil Jute | Kattu vendai | LC |
| 43 | *Mangifera indica* | T | Mango Tree | Maamaram | LC |
| 44 | *Mimosa pudica* | H | Touch Me Not | Thottaisurungi | LC |
| 45 | *Morinda pubescens* | T | Morinda Tree | Mannanunai | LC |
| 46 | *Nelumbo nucifera* | M | Indian Lotus | Thamarai | LC |
| 47 | *Nymphaea pubescens* | M | Pink Water-Lily | Alli | LC |
| 48 | *Nymphaea nouchali* | M | Blue Water-Lily | Alli | LC |
| 49 | *Operculina turpethum* | H | Morning Glory | Paganrai | LC |
| 50 | *Oxystelma secamone* | H | Needle Milkweed | Oosipaalai | LC |
| 51 | *Passiflora foetida* | C | Passion Flower | Siruppunaikkali | LC |
| 52 | *Pedalium murex* | H/W | Sand Murex | Aanainerinji | LC |
| 53 | *Perotis indica* | H | Indian Comet Grass | Kudiraival pullu | LC |
| 54 | *Pongamia pinnata* | T | Indian Beech | Punga maram | LC |
| 55 | *Polygonum glabrum* | H | Knotweed | Attalaree | LC |
| 56 | *Polyalthia longifolia* | T | Asoka Maram | Nettilingam | LC |

| S. N | Botanical Name | Habit | Common Name | Local Name | IUCN / Wildlife Protection Act 1972 - Status |
|---|---|---|---|---|---|
| 57 | *Phyllanthus amarus* | H | Ground Gooseberry | Keelanelli | LC |
| 58 | *Phyla nodiflora* | H | Creeping Lip Plant | Potutalai | LC |
| 59 | *Phyllanthus reticulatus* | S | Black Gooseberry | Inki pazham | LC |
| 60 | *Pistia stratiotes* | M | Water Lettuce | Antarattamarai | LC |
| 61 | *Prosopis juliflora* | ST/W | Algaroba bean | Kattukaruvai | LC |
| 62 | *Psidium guajava* | T | Common Guava | Koyya | LC |
| 63 | *Ricinus communis* | S | Castor oil Plant | Amanakku | LC |
| 64 | *Salvadora persica* | T | Toothbrush Tree | Peru-vila | LC |
| 65 | *Spirodela polyrhiza* | M | Duck Weed | Paasi | LC |
| 66 | *Tamarindus indica* | T | Tamarind | Puli Maram | LC |
| 67 | *Thespesia populnea* | T | Indian Tulip Tree | Poovarasu | LC |
| 68 | *Turnera ulmifolia* | H | Yellow Alder | Cheravathali | LC |
| 69 | *Typha angustata* | A/W | Indian Reed Mace | Sambu | LC |
| 70 | *Tridax procumbens* | H | Tridax Daisy | Vettukkaaya-thalai | LC |
| 71 | *Vitex negundo* | S | Chaste Tree | Nochi | LC |
| 72 | *Wolffia globosa* | M | Duck Weed | Paasi | LC |
| 73 | *Ziziyphus oenoplia* | S | Jackal jujube | Surai Ilantai | LC |

T – Tree ST-Small Tree S – Shrub H – Herb C-Climber W-Weed A-Aquatic; LC – least concern, NE = not evaluated

**Table 26: Summary on comparative Assessment of Floral species between the Lakes**

| Flora | Floral Assessment of Lakes | | | | | | |
|---|---|---|---|---|---|---|---|
| | Ambattur | Korattur | Retteri | Madhavaram | Ariyallur | Kadapakkam | Sadayankuppam |
| Macrophytes | 5 | 8 | 5 | 4 | 9 | 9 | 6 |
| Herbs/ weeds /climbers | 23 | 29 | 21 | 28 | 31 | 33 | 29 |
| Shrubs | 8 | 9 | 8 | 8 | 9 | 10 | 8 |
| Trees | 11 | 15 | 13 | 13 | 16 | 14 | 13 |

**Table 27: Summary on comparative Assessment of Macro-fauna between the Lakes**

| Macro Fauna | Macro Fauna Assessment of Lakes | | | | | | |
|---|---|---|---|---|---|---|---|
| | Ambattur | Korattur | Retteri | Madhavaram | Ariyallur | Kadapakkam | Sadayankuppam |
| Butterflies | 23 | 26 | 18 | 19 | 27 | 25 | 18 |
| Dragonflies | 9 | 11 | 8 | 7 | 11 | 12 | 9 |
| Damselflies | 4 | 5 | 3 | 2 | 5 | 5 | 4 |
| Amphibians | 7 | 7 | 6 | 5 | 6 | 6 | 5 |
| Fishes | 10 | 13 | 9 | 9 | 14 | 16 | 12 |
| Reptiles | 14 | 22 | 16 | 19 | 21 | 20 | 16 |
| Birds | 42 | 54 | 36 | 41 | 59 | 60 | 58 |
| Mammals | 6 | 6 | 5 | 5 | 6 | 6 | 5 |

**Table 28: List of Faunal Species in the Project area and their Conservation Status**

| S. N | Scientific Name | Common Name | IUCN / Wildlife Protection Act 1972 -Status |
|---|---|---|---|
| | **Butterflies** | | |

| S. N | Scientific Name | Common Name | IUCN / Wildlife Protection Act 1972 -Status |
|---|---|---|---|
| 1 | *Acraea terpsicore* | Tawny Coster | LC |
| 2 | *Ariadne merione* | Common Castor | LC |
| 3 | *Euploea core* | Common Crow | LC |
| 4 | *Everes lacturnus* | Indian Cupid | LC |
| 5 | *Euchrysops cnejus* | Gram Blue | LC |
| 6 | *Eurema hecabe* | Common Grass Yellow | NE |
| 7 | *Euploea core* | Common Indian Crow | LC |
| 8 | *Catochrysops strabo* | Forget-Me-Not | LC |
| 9 | *Catopsilia Pomona* | Common Emigrant | NE |
| 10 | *Castalius rosimon* | Common Pierrot | NE, Schedule I - Part IV |
| 11 | *Danaus genutia* | Striped Tiger | LC |
| 12 | *Danaus chrysippus chrysippus* | Plain Tiger | LC |
| 13 | *Hypolimnas misippus* | Danaid Eggfly | LC |
| 14 | *Hypolimnas bolina* | Great Eggfly | LC |
| 15 | *Hypolimnas misippus* | Danaid Eggfly | LC |
| 16 | *Jamides celeno celeno* | *Common Cerulean* | LC |
| 17 | *Junonia almana* | Peacock Pansy | LC |
| 18 | *Junonia hierta* | Yellow Pansy | LC |
| 19 | *Junonia lemonias* | Lemon Pansy | LC |
| 20 | *Junonia orithya* | Blue Pansy | LC |
| 18 | *Lampides boeticus* | Pea Blue | LC |
| 19 | *Melanitis leda leda* | *Common Evening Brown* | LC |
| 20 | *Papilio polytes polytes* | *Common Mormon* | LC |
| 21 | *Pachliopta aristolochiae* | Common Rose | LC |
| 22 | *Papilio demoleus demoleus* | *Lime Butterfly* | LC |
| 23 | *Phalanta phalantha* | Common Leopard | LC |
| 24 | *Spindasis vulcanus* | Common Silverline | LC |
| 25 | *Tirumala Septentrionis* | Dark Blue Tiger | LC |
| 26 | *Ypthima baldus* | Common Five-ring | LC |
| 27 | *Zizula hylax* | Tiny Grass Blue | LC |
| | **Dragonfly and Damselflies** | | |
| 1 | *Acisoma panorpoides* | Trumpet Tail | LC |
| 2 | *Brachythemis contaminata* | Ditch Jewel | LC |
| 3 | *Crocothemis servilia* | Red Marsh Skimmer | LC |
| 4 | *Diplacodes trivialis* | Ground Skimmer | LC |
| 5 | *Diplacodes Nebulosa* | Black Tipped Ground Skimmer | LC |
| 6 | *Ictinogomphus Rapax* | Common Clubtail | LC |
| 7 | *Orthetrum cancellatum* | Black Tailed Skimmer | LC |
| 8 | *Pantala Flavescens* | Wandering Glider | LC |
| 9 | *Rhyothemis variegata* | Common Picture Wing | LC |
| 10 | *Tramea limbata* | Black Marsh Trotter | LC |
| 11 | *Trithemis aurora* | Crimson Marsh Glider | LC |

| S. N | Scientific Name | Common Name | IUCN / Wildlife Protection Act 1972 -Status |
|---|---|---|---|
| 12 | *Trithemis pallidinervis* | Long-Legged Marsh Glider | LC |
| 13 | *Coenagrion puella* | Azure Damselfly | LC |
| 14 | *Copera Marginipes* | Yellow Bush Dart | LC |
| 15 | *Copera Vittata* | Blue Bush Dart | LC |
| 16 | *Enallagma annexum* | The Northern Blue | LC |
| 17 | *Lestes sponsa* | Emerald Damselfly | LC |
| | **Fishes** | | |
| 1 | *Channa punctatus* | Spotted Snakehead | LC |
| 2 | *Esomus danricus* | Flying Barb | LC |
| 3 | *Etroplus maculates* | Orange Chromide | LC |
| 4 | *Etroplus suratensis* | Green Chromide | LC |
| 5 | *Gambusia affinis* | Mosquitofish | LC |
| 6 | *Glossogobius giuris* | Tank Goby | LC |
| 7 | *Heteropneustes fossilis* | Stinging Catfish | LC |
| 8 | *Macrognathus pancalus* | **Indian** Spiny Eel | LC |
| 9 | *Mystus keletius* | Kelethi | LC |
| 10 | *Notopterus notopterus* | Bronze Fetherback | LC |
| 11 | *Oreochromis mossambica* | Tilapia | LC |
| 12 | Pethia conchonius | Rosy Barb | LC |
| 13 | *Puntius chola* | Swamp Barb Or Chola Barb | LC |
| 14 | *Puntius filamentosus* | Black-Spot Barb | LC |
| 15 | *Puntius vittatus* | Greenstripe Barb | LC |
| 16 | *Pseudosphromenus cupanus* | Spiketail Paradisefish | LC |
| 17 | *Trichopodus trichopterus* | Three Spot Gourami | LC |
| | **Amphibians** | | |
| 1 | *Bufo melanosticus* | Common Indian Toad | LC |
| 2 | *Erphlyctis hexadactylus* | Indian Pond Frog | LC |
| 3 | *Enallagma annexum* | The Northern Bluet | LC |
| 4 | *Euphlyctis hexadactylus* | Indian Pond Frog | LC |
| 5 | *Euphlyctis cyanophlyctis* | Skipper Frog | LC |
| 6 | *Polypedates maculates* | Common Tree Frog | LC |
| 7 | *Rana tigrina* | Common Frog | LC |
| | **Reptiles** | | |
| 1 | *Lissemys punctata* | Flapshell Turtle | LC |
| 2 | *Hemidactylus frenatus* | House Gecko | LC |
| 3 | *Hemidactylus brook* | Brook's Gecko | LC |
| 4 | *Hemidactylus leschenault* | Bark Gecko | LC |
| 5 | *Mabuya carinata* | Keeled Grass Skink | LC |
| 6 | *Mabuya macularia* | Little Skink | |
| 7 | *Riopa punctata* | Spotted Supple Skink | LC |
| 8 | *Catotes versicolor* | Common Garden Lizard | LC |
| 9 | *Sitana ponticeriana* | Fan Throated Lizard | LC |

| S. N | Scientific Name | Common Name | IUCN / Wildlife Protection Act 1972 -Status |
|---|---|---|---|
| | **Snakes** | | |
| 1 | *Ahaetulla nasuta* | Common Vine Snake | NE, Schedule IV |
| 2 | *Amphiesma stolatum* | Buff Striped Keelback | LC |
| 3 | *Atretium schistosum* | Split Keelback | LC |
| 4 | *Bungarus caeruleus* | Common Krait | NE, Schedule II |
| 5 | *Calliophis melanurus* | Slender Coral Snake | LC |
| 6 | *Dendrelaphis tristis* | Bronzeback Tree Snake | NE, Schedule IV |
| 7 | *Eryx conicus* | Common Sand Boa | NE, Schedule IV |
| 8 | *Indotyphlops braminus* | Brahminy Blind Snake | NE, Schedule IV |
| 9 | *Lycodon aulicus* | Indian Wolf Snake | LC |
| 10 | *Naja naja* | Indian Cobra | LC |
| 11 | *Oligodon taeniolatus* | Streaked Kukri Snake | NE, Schedule IV |
| 12 | *Ptyas mucosus* | Indian Rat Snake | LC |
| 13 | *Xenochrophis piscator* | Checkered Keelback | NE, Schedule II |
| | **Mammals** | | |
| 1 | *Cynopterus sphinx* | Short-Nosed Fruit Bat | LC |
| 2 | *Funambulus palmarum* | Indian Palm Squirrel | LC |
| 3 | *Herpestes Edwardsii* | Grey Mongoose | LC |
| 4 | *Rattus norvegicus* | Field Mouse | LC |
| 5 | *Rattus rattus* | House Rat | LC |
| 6 | *Suncus murinus* | House Shrew | LC |

NE - Near Evaluated, LC - Least Concerned

### 1. Protected Areas

86. There are no protected areas such as national parks, wildlife sanctuaries etc. in or adjacent to the project area. To profile the nearest protected areas, 50 km radius from the project site were screened using the Integrated Biodiversity Assessment Tool (IBAT). Pullicat Lake and Guindy National Park are the two protected areas located within 50 km of the project area (Figure 15). Pullicat Lake's nearest point is at about 21 km north and Guindy National Park is about 10 km south from the project boundary. Salient features of these protected areas are given below. The project will not interfere or influence the catchment area of Pullicat Lake, since the project area is far from the catchment of the Pullicat Lake and also the existing topography doesn't support it (Kosasthalaiyar basin drains towards the east). The Guindy National park is restricted to the urban environment, and is far away from the project area, and receives water needs from the Cooum basin catchments. No likely interference due to project.

(i) **Guindy National Park (GNP).** Spread over 2.70 $km^2$, this national park located in the heart of Chennai, and is the 8th smallest national park in India and one of the very few national parks situated inside a city. Though park is urban limits, it is well protected and managed. Park boasts 350 species of plants include shrubs, herbs, climbers, and grasses, there are more than and over 24 variety of trees, including the sugar-apple, *Atlantia monophylla, wood-apple, Annona squamosa, Atlanta monoplylla, Feronia limonia, Azadirachta indica* and many others are found in this park. The park and the diverse vegetation provide an ideal habitat for over 150 species of birds. 9 species of amphibians, 14 species of mammals, 3 species of

tortoise and turtles 60 species of spiders and 60 species of butterflies. About one-sixth area of the park is left as open grass land to preserve the habitat for blackbucks.

(ii) **Pullicat Lake.** Spread over 450 km$^2$ area in Tamil Nadu and Andhra Pradesh states, this is the second largest brackish-water eco-system in the country next to Chilika Lake in the State Orissa. The boundary of lake is at about 21 km from the project area. The Pullicat Lake was once permanently connected with the Ennore estuary. A total of 180 species of floral species are reported from Pullicat Lake, of which 6 species are mangroves and 35 species are mangrove associated. Ornithologically rich, 115 species of birds are listed from both water (aquatic) as well as land (terrestrial) in the Pullicat Bird Sanctuary. Six species of water birds; Great Thick-knee Esacus recurvirostris, Black-Tailed Godwit Limosa limosa, Eurasian Curlew Numenius arquata, Painted Stork Mycteria leucocephala, Spot-billed Pelican Pelecanus philippensis and Black-headed Ibis Threskiornis melanocephalus were categorised as “Near Threatened” according to the International Union for Conservation of Nature (IUCN) Red List. Five species of raptors Black-winged Kite Elanus caeruleus, Oriental Honey Buzzard Pernis ptilorhynchus, Shikra Accipiter badius, Brahminy Kite Haliastur Indus and Whitebellied Sea eagle Haliaeetus leucogaster were categorized as “Schedule I” according to the Wildlife Protection Act 1972. The Migratory species come to Pullicat from many habitats in India and other countries during different times of the year, due to seasonal limitations in factors such as food, sunlight, and temperature.

**Figure 15: Protected Areas located within 50 km radius of the Project Area**

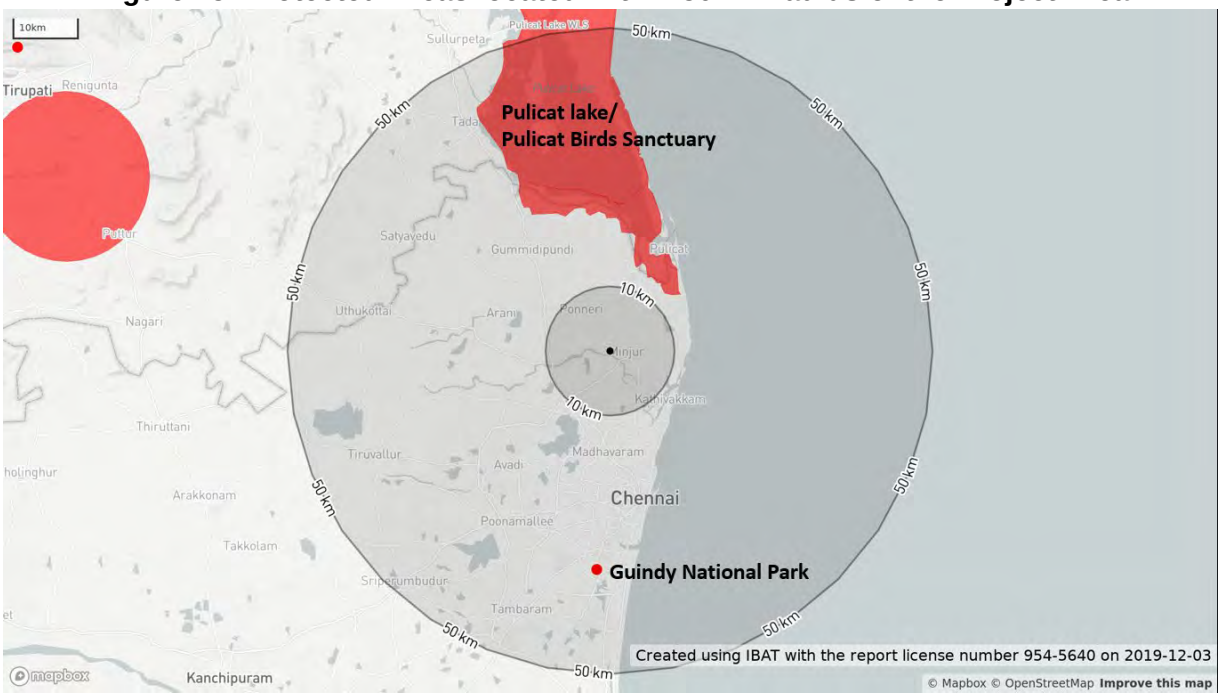
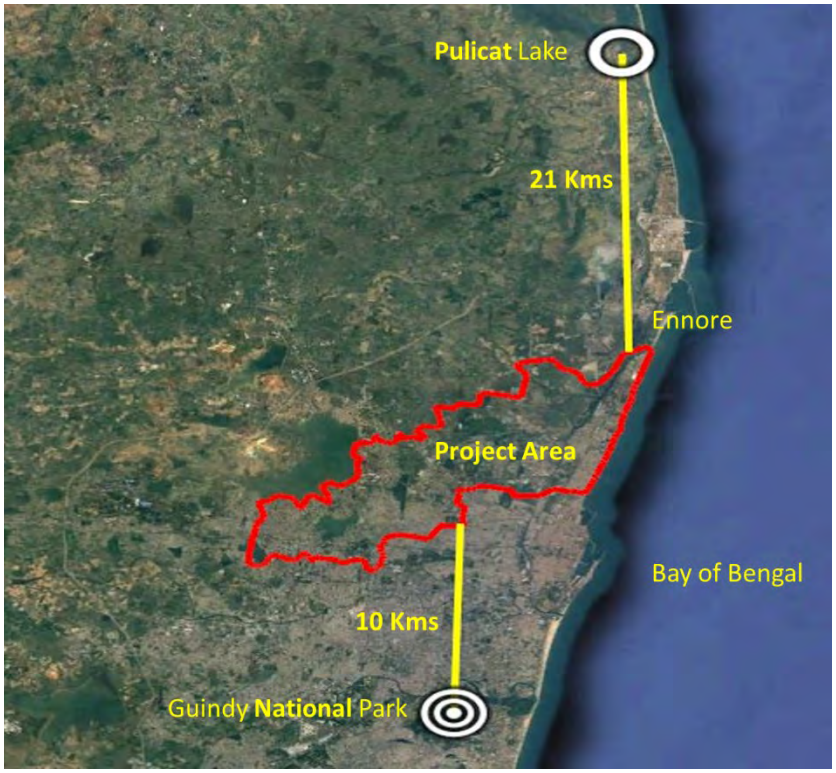


**Figure 16: Distance of Pullicat Lake and Guindy National Park from the project area**




87. Protected Species within 50 km Buffer Area. Potential occurrence of Critically Endangered (CR) / Endangered Species (EN), Near Threatened (NT) species listed in the IUCN Red List from IBAT screening is presented in **Table 29**. Except the birds and terrestrial species listed, others are marine animals have a larger home range. The potential occurrence is influenced by the two protected areas that are within this 50 km buffer of the project area.

**Table 29: List of Species based on 50 km Buffer from the Project site (IBAT)**

| S. N | Scientific Name | Common Name | Habit | IUCN Status | Inference |
|---|---|---|---|---|---|
| 1 | *Eretmochelys imbricata* | Hawksbill Turtle | Terrestrial, Marine | CR | No influence on this species home range |
| 2 | *Glyphis gangeticus* | Ganges Shark | Marine, Freshwater | CR | No influence on this species home range |
| 3 | *Carcharhinus hemiodon* | Pondicherry Shark | Marine | CR | No influence on the species home range |
| 4 | *Carcharhinus longimanus* | Oceanic Whitetip Shark | Marine | CR | project site is away from this species home range |
| 5 | *Sphyrna lewini* | Scalloped Hammerhead | Marine | CR | project site is away from this species home range |
| 6 | *Sphyrna mokarran* | Great Hammerhead | Marine | CR | No influence on this species home range |
| 7 | *Pristis zijsron* | Green Sawfish | Marine | CR | project site is away from this species home range |

| S. N | Scientific Name | Common Name | Habit | IUCN Status | Inference |
|---|---|---|---|---|---|
| 8 | *Rhina ancylostoma* | Bowmouth Guitarfish | Marine | CR | No influence on this species home range |
| 9 | *Rhynchobatus australiae* | Bottlenose Wedgefish | Marine | CR | No influence on the species home range |
| 10 | *Rhynchobatus laevis* | Smoothnose Wedgefish | Marine | CR | No influence on the species home range |
| 11 | *Glaucostegus granulatus* | Sharpnose Guitarfish | Marine | CR | project site is away from this species home range |
| 12 | *Glaucostegus obtusus* | Widenose Guitarfish | Marine | CR | project site is away from this species home range |
| 13 | *Glaucostegus thouin* | Clubnose Guitarfish | Marine | CR | No influence on the species home range |
| 14 | *Pristis pristis* | Largetooth Sawfish | Marine | CR | No influence on this species home range |
| 15 | *Gyps bengalensis* | White-rumped Vulture | Terrestrial | CR | Rarely sighted in Pullicat and well away from the site |
| 16 | *Sarcogyps calvus* | Red-headed Vulture | Terrestrial | CR | Rarely sighted in Pullicat and well away from the site |
| 17 | *Gyps indicus* | Indian Vulture | Terrestrial | CR | Rarely sighted in Pullicat and well away from the site |
| 18 | *Glaucostegus typus* | Giant Guitarfish | Marine | CR | No influence on the species home range |
| 19 | *Balaenoptera musculus* | Blue Whale | Marine | EN | No influence on this species home range |
| 20 | *Manis crassicaudata* | Indian Pangolin | Terrestrial | EN | Not recorded within the 50km radius |
| 18 | *Rhincodon typus* | Whale Shark | Marine | EN | No influence on this species home range |
| 19 | *Isurus oxyrinchus* | Shortfin Mako | Marine | EN | No influence on this species home range |
| 20 | *Anoxypristis cuspidata* | Narrow Sawfish | Marine | EN | Marine species |
| 21 | *Pristis clavata* | Dwarf Sawfish | Marine | EN | Marine species |
| 22 | *Eusphyra blochii* | Winghead Shark | Marine | EN | Marine species |
| 23 | *Stegostoma tigrinum* | Zebra Shark | Marine | EN | Marine species |
| 24 | *Aetobatus flagellum* | Longhead Eagle Ray | Marine | EN | Deep water species, far away from site |
| 25 | *Aetomylaeus maculatus* | Mottled Eagle Ray | Marine | EN | Deep water species, far away from site |
| 26 | *Aetomylaeus vespertilio* | Ornate Eagle Ray | Marine | EN | No influence on this species home range |
| 27 | *Mobula tarapacana* | Sicklefin Devilray | Marine | EN | No influence on this species home range |
| 28 | *Mobula thurstoni* | Bentfin Devilray | Marine | EN | Marine species, deep waters |
| 29 | *Isurus paucus* | Longfin Mako | Marine | EN | Marine species, deep waters |

| S. N | Scientific Name | Common Name | Habit | IUCN Status | Inference |
|---|---|---|---|---|---|
| 30 | *Acropora rudis* | | Marine | EN | Marine species, deep waters |
| 31 | *Mobula kuhlii* | Shortfin Devilray | Marine | EN | Marine species, deep waters |
| 32 | *Lamiopsis temminckii* | Broadfin Shark | Marine | EN | Marine species, deep waters |
| 33 | *Alopias pelagicus* | Pelagic Thresher | Marine | EN | Marine species, deep waters |
| 34 | *Lindernia minima* | | Freshwater | EN | No record within range of the project area |
| 35 | *Holothuria scabra* | Golden Sandfish | Marine | EN | Marine species, deep waters |
| 36 | *Holothuria lessoni* | Golden Sandfish | Marine | EN | Marine species, deep waters |
| 37 | *Thelenota ananas* | Prickly Redfish | Marine | EN | No influence on this species home range |
| 38 | *Sypheotides indicus* | Lesser Florican | Terrestrial | EN | Visitor, not resident and no influence |
| 39 | *Calidris tenuirostris* | Great Knot | Terrestrial Marine | EN | Rarely sighted |
| 40 | *Sterna acuticauda* | Black-bellied Tern | Terrestrial | EN | Visitor, not resident and no influence |
| 41 | *Neophron percnopterus* | Egyptian Vulture | Terrestrial | EN | Rarely sighted in Pullicat, which is far from the site and has no influence on the species |
| 42 | *Aquila nipalensis* | Steppe Eagle | Terrestrial | EN | Rarely sighted in Pullicat, which is far from the site and has no influence on the species |
| 43 | *Lonchura oryzivora* | Java Sparrow | Terrestrial | EN | Rarely sighted to far from the site |
| 44 | *Mobula mobular* | Spinetail Devil Ray | Marine | EN | Not sighted within the 50km range, No influence on this species home range |
| 45 | *Acentrogobius veliensis* | | Marine | EN | Marine species, deep waters |
| 46 | *Oceanites oceanicus* | Wilson's Stormpetrel | Terrestrial Marine | EN | Rarely sighted at Pullicat |
| 47 | *Fregetta tropica* | Black-bellied Storm-petrel | Terrestrial Marine | EN | Rarely sighted at Pullicat |

### 2. Coastal Areas

88. Project area is located along the coromandel coast of the Bay of Bengal. Project area slopes towards the coast, and the Kosathalaiyar River drains into the Bay of Bengal via Ennore Creek. Ennore creek is the north most tip of the project area. Figure 17 shows the coastal location of the project area.

89. **The Ennore Creek** (estuary) is at the tail end of the project, it is a shallow water body influenced by tidal fluctuations, and the depth of the creek is up to 2 - 3 m. The Northern region of the estuary harbors very less mangroves and more saltmarsh areas, the Southern region is the tail end of the Kosasthalaiyar River, which has tidal mudflats, mangroves, salt marsh and the coastal wetland. Once a thriving mangrove forest, this habitat has drastically changed from mangrove and saltmarsh ecosystem to degraded and fragmented habitats. Mangrove patches highly fragmented, disturbed and growth stunted due to heavy siltation and salinity. One mangrove species and 56 mangrove associate and coastal vegetation species is recorded; details of the species list are attached in **Appendix 9**. 30 species of crabs and 36 species of Mollusca species were identified of which 24 species were gastropods and 15 species were bivalves. More than 100 species of water and terrestrial birds around the Ennore estuary has been listed by many bird watchers and researchers.

90. All the species were not totally dependent on the estuary they use the estuary environment for roosting, foraging and as a seasonal stop-over site on migrations. Most of the species were from the adjacent villages and urban areas. Some common species recorded were herons, egrets, sandpipers, whistlers and kingfisher. Migratory birds visiting Pullicat lake visit Ennore estuary as well. Similar to Pullicat lake five species of water birds; Black-Tailed Godwit Limosa limosa, Painted Stork Mycteria leucocephala, Spot-billed Pelican Pelecanus philippensis and Black-headed Ibis Threskiornis melanocephalus were categorized as “Near Threatened” according to the International Union for Conservation of Nature (IUCN) Red List. Five species of raptors Black-winged Kite Elanus caeruleus, Oriental Honey Buzzard Pernis ptilorhynchus, Shikra Accipiter badius, Brahminy Kite Haliastur indus and White bellied Sea eagle Haliaeetus leucogaster were categorised as “Schedule I” according to the Wildlife Protection Act 1972. The above listed bird species rarely visit the Estuary except Painted Stork, Spot-billed Pelican, Shikra, Brahminy Kite and White bellied Sea eagle, details of the species list is attached in **Appendix 9**. There are no endemic and endangered species in this area,

91. A total of 61 km of length of drain (both existing and proposed) falling in the CRZ area, mostly in CRZ II. Besides, as the project areas topographically drains into Bay of Bengal directly or via Kosasthalaiyar River, Buckingham canal and Ennore Creek, some outfalls and discharge locations are falling within the CRZ. At all locations, water channels/canals already exist albeit in poor condition and siltation. As per Notification, CRZ-II is the developed land areas up to or close to the shoreline, within the existing municipal limits or in other existing legally designated urban areas, which are substantially built-up. CRZ-IV B areas shall include the water area and the bed area between LTL at the bank of the tidal influenced water body to the LTL on the opposite side of the bank, extending from the mouth of the water body at the sea up to the influence of tide.

92. Both the pumping stations are located in CRZ II. Four outfalls are existing in the Ennore estuary, and there are 13 outfalls into the Bay of Bengal are not direct outfalls into the sea, they either drain on the rocks (sea wall) or extend along the beach and drain along the rocks. Very few and sparse vegetation was observed along and near the outfalls either in the Ennore estuary or the beach, the outfalls were elevated from the mean sea level. In Ennore estuary, mangroves were about 500 m away from the discharge point on the opposite side. Common coastal plants like *Cassia occidentalis*, *Canavalia cathartica*, *Canavalia maritima*, *Calotropis gigantean*, *Acalypha indica*, *Achyranthes aspera*, *Ricinus communis*, *Tephrosia p*urpurea and *Triumfetta rhomboidea* and sea weeds like *Enteromorpha compressa*, *Enteromorpha flexuosa*, and Gracillaria *foliifera* were identified near the outfalls along Ennore estuary and the sea and which were found in very few numbers and are neither ecologically or economically important. Crab species like Uca annulipes and *Neoepisesarma tetragonam* were identified, which were not economically important species.

93. The species diversity within the outfall area is very less, neither rare, nor of significance in terms of economic or ecological value. Along the outlets draining into the sea crossing the Ennore road, the diversity was dominated by crustacean and molluscan species, very less or no diversity was observed on the outfall areas of the proposed landfall site. Barnacles and sea weeds were observed in the sea wall built along the shore. The upper shore habitats, along the Ennore road are residential and industrial development, topography was loose sand; no or less vegetation and no macro fauna were recorded. Changes to beach morphology, changes to water quality, damage to coastal structures or deposition within the outfall region is not expected and the storm water outfall will not alter the Benthic Intertidal Ecology, if few changes happen, it will be temporary and short term.

**Figure 17: View of Ennore Estuary, Kosasthalaiyar River and Buckingham canal**

**Figure 18: The Coastal Zone Management Plan Map**

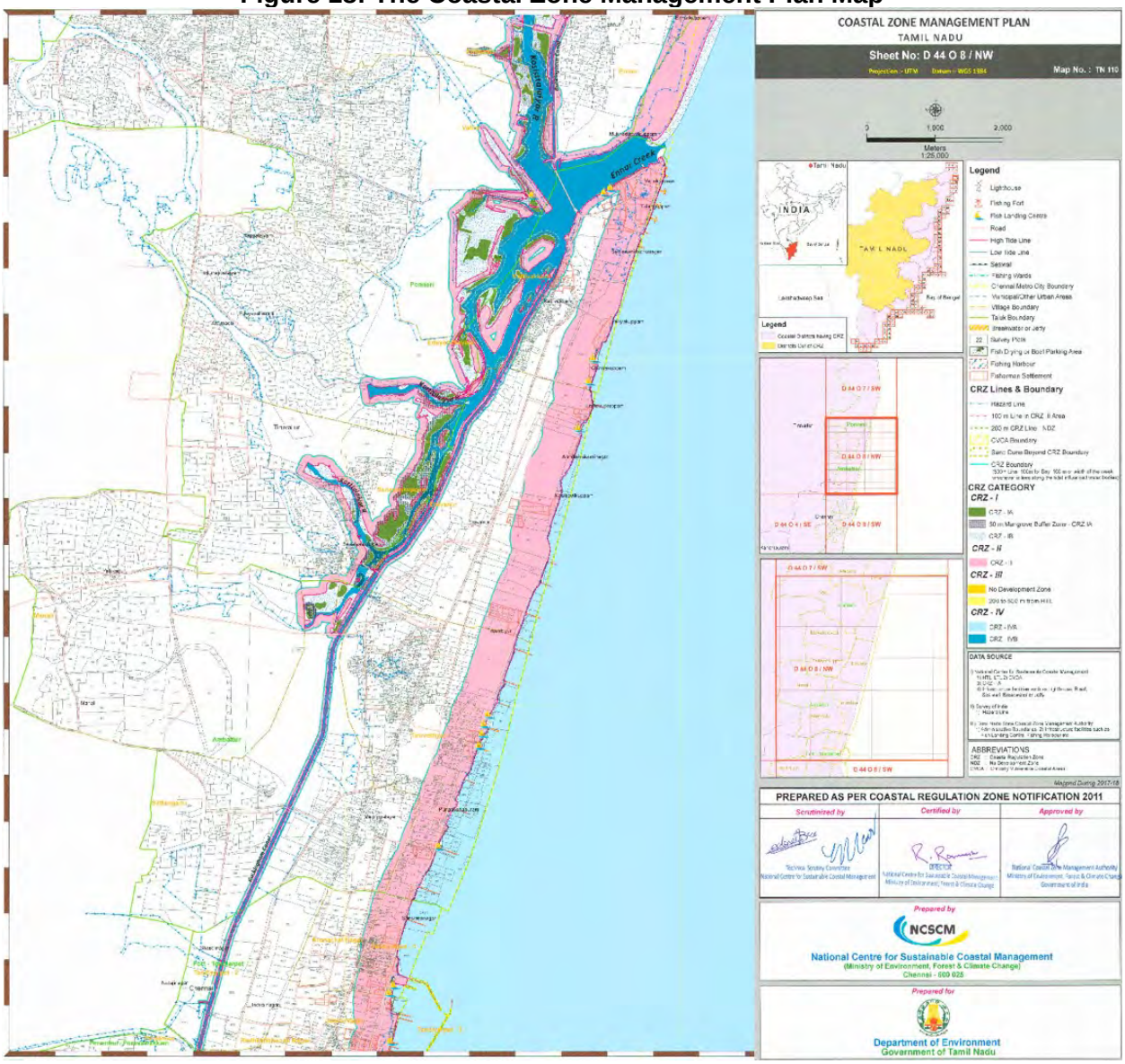


**Figure 19: The view of discharge outfall into Sea and Creek**

## D. Socio-economic Environment

### 1. Demography

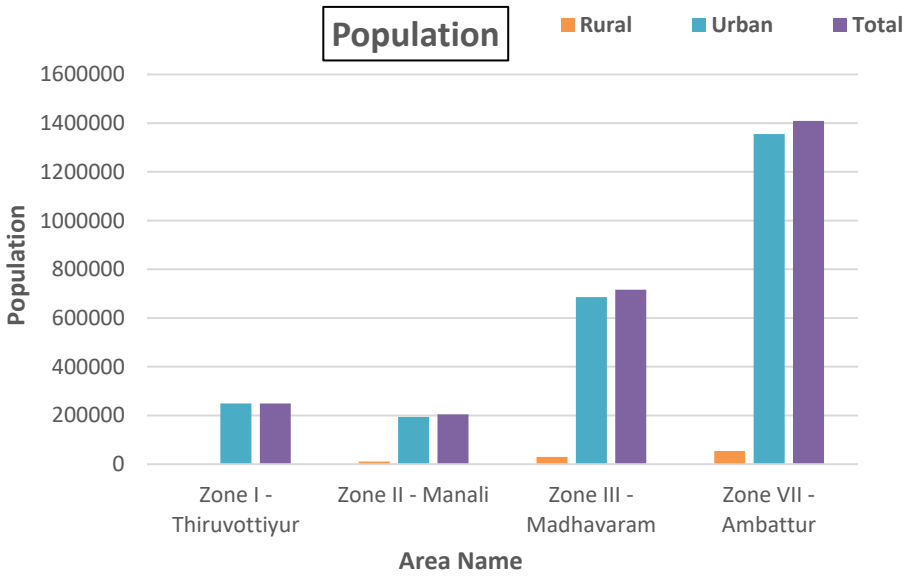
94. As per census 2011, the population in the Kosasthalaiyar River Basin is 2,579,645. The detail of the population distribution is given in the **Table 30** Within the project area, the urban population is observed to be high in the Zone VII Ambattur and low in Zone II Manali. Rural population is nil for Zone I Tiruvottiyur and high in Zone VII Ambattur. Nearly 3.68% and 96.32% lives in rural and urban areas respectively.

**Table 30: Socio-economic data (Census 2011)**

| Area Name | House holds | | | Total Population | | | % of urban population | Woman Headed Family |
|---|---|---|---|---|---|---|---|---|
| | Rural | Urban | Total | Rural | Urban | Total | | |
| Zone I-Thiruvottiyur | 0 | 63,862 | 63,862 | 0 | 249,446 | 249,446 | 100% | 14,459 |
| Zone II-Manali | 2,368 | 19,359 | 21,727 | 10,602 | 194,146 | 204,748 | 95% | 4,246 |

| Area Name | House holds | | | Total Population | | | % of urban population | Woman Headed Family |
|---|---|---|---|---|---|---|---|---|
| | Rural | Urban | Total | Rural | Urban | Total | | |
| Zone III-Madhavaram | 7,802 | 146,365 | 154,167 | 30,148 | 685,901 | 716,049 | 96% | 4,158 |
| Zone VII-Ambattur | 13,518 | 227,729 | 241,247 | 54,085 | 1,355,317 | 1,409,402 | 96% | 178,434 |
| **Total** | **23,688** | **457,315** | **481,003** | **94,835** | **2,484,810** | **2,579,645** | 96% | **201,297** |
| **Percentage (%)** | **4.92** | **95.08** | **100** | **3.68** | **96.32** | **100** | | **7.80** |

**Figure 20: Rural and Urban Population in Project area**



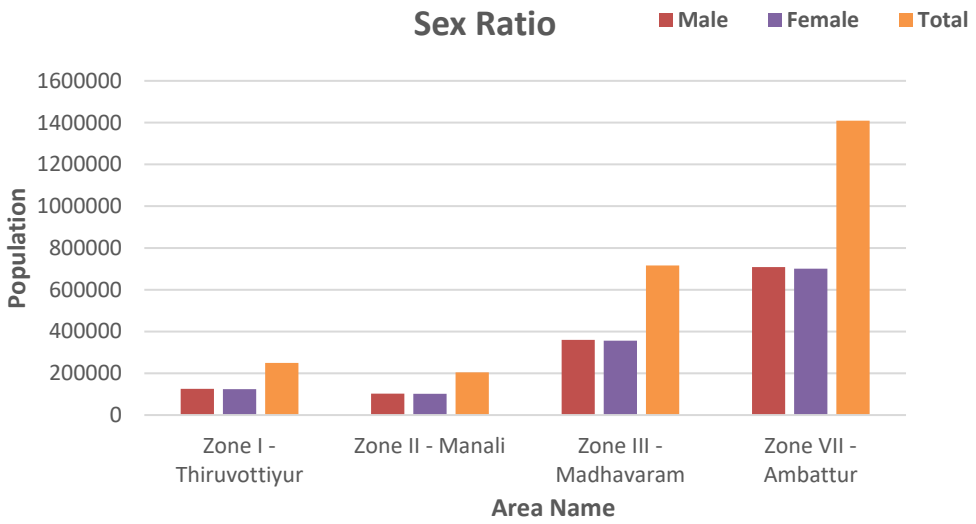

## 2. Sex Ratio

95. Among the total population, sex ratio is 989 females for 1000 males. Sex disaggregate population is given in the following table.

**Table 31: Sex Ratio**

| Area Name | Sex Ratio | | |
|---|---|---|---|
| | Male | Female | Total |
| Zone I - Thiruvottiyur | 125,393 | 124,053 | 249,446 |
| Zone II - Manali | 102,924 | 101,824 | 204,748 |
| Zone III - Madhavaram | 359,947 | 356,102 | 716,049 |
| Zone VII - Ambattur | 708,486 | 700,916 | 1,409,402 |
| **Total** | **1,296,750** | **1,282,895** | **2,579,645** |
| **Percentage (%)** | **50.27** | **49.73** | |

**Figure 21: Sex Ratio in Project Area**



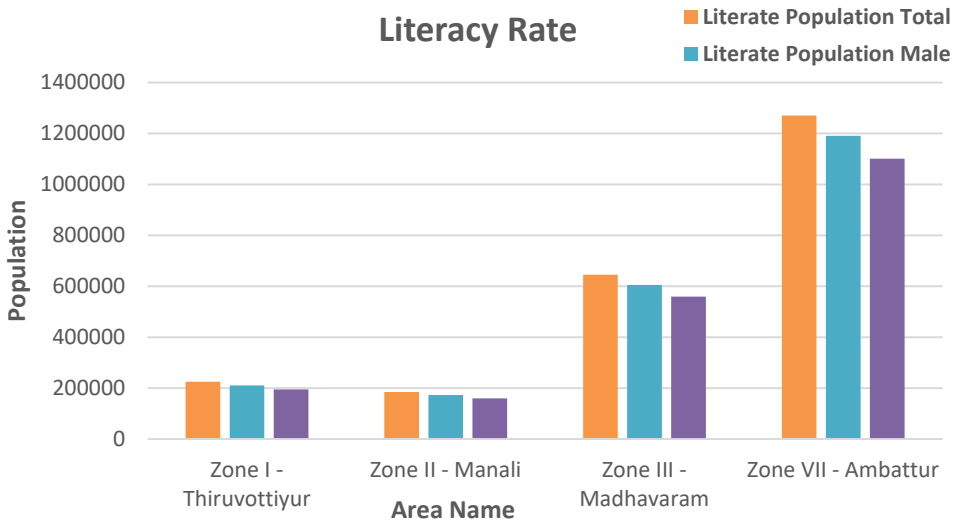

### 3. Literacy

96. Among the total population, 90.17% is educated out of which male literacy rate is 93.70% and women literacy rate is 92.47%. Within the project area, Zone VII Ambattur has highest literate population and Zone II Manali has lowest literate population.

**Table 32: Literacy Rate in the Project Area**

| Area Name | Literate Population | | | Illiterate Population |
|---|---|---|---|---|
| | Total | Male | Female | |
| Zone I – Thiruvottiyur | 224,925 | 210,755 | 194,875 | 24,521 |
| Zone II – Manali | 184,621 | 172,990 | 159,956 | 20,127 |
| Zone III - Madhavaram | 645,661 | 604,984 | 559,401 | 70,388 |
| Zone VII - Ambattur | 1,270,858 | 1,190,794 | 1,101,071 | 138,544 |
| **Total** | **2,326,065** | **2,179,523** | **2,015,303** | **253,580** |
| **Percentage (%)** | **90.17** | **93.70** | **92.47** | **9.83** |

**Figure 22: Literacy rate details in Zone I, II, III and VII areas**



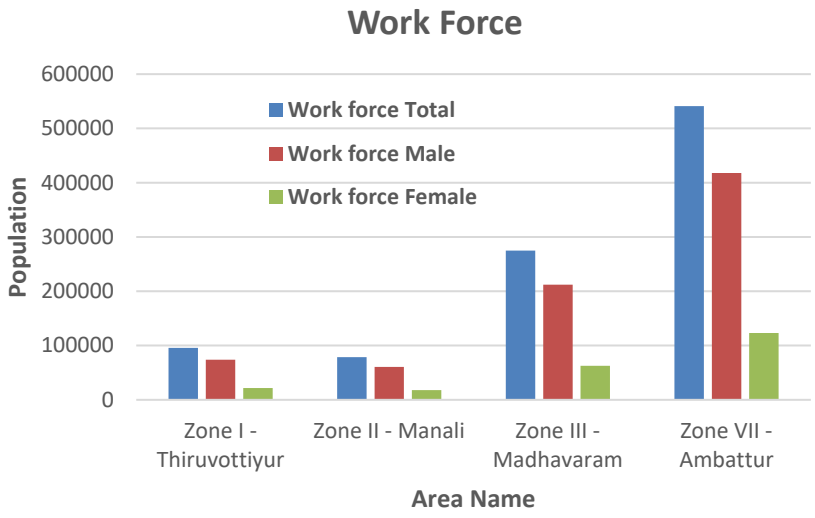

### 4. Work Force

97. Highest workforce population is in Zone VII Ambattur and lowest work force population is in Zone II Manali. Among the total work force, male and female work force are 77.23% and 22.77% respectively.

**Table 33: Work Force**

| Area Name | Work force | | |
|---|---|---|---|
| | Total | Male | Female |
| Zone I - Thiruvottiyur | 95,756 | 73,950 | 21,806 |
| Zone II - Manali | 78,597 | 60,699 | 17,898 |
| Zone III - Madhavaram | 274,872 | 212,277 | 62,595 |
| Zone VII - Ambattur | 541,032 | 417,826 | 123,206 |
| **Total** | **990,257** | **764,752** | **225,505** |
| **Percentage (%)** | | **77.23** | **22.77** |

**Figure 23: Work Force in Project Area**



## 5. Land Use

98. The project area has various types of land use patterns. Watershed wise land use details are given in the **Table 34**. The land use pattern was dominated by the residential (41.62 $km^2$), followed by commercial cum residential (20.61 $km^2$), Industrial (19.52 $km^2$), Water bodies (13.71 $km^2$) and CRZ area (3.19 $km^2$). CRZ area is in two watershed basins of North Buckingham canal zone and North coast watershed zone.

**Figure 24: Land Use Map Chennai Metro Area (Source CMDA Database)**

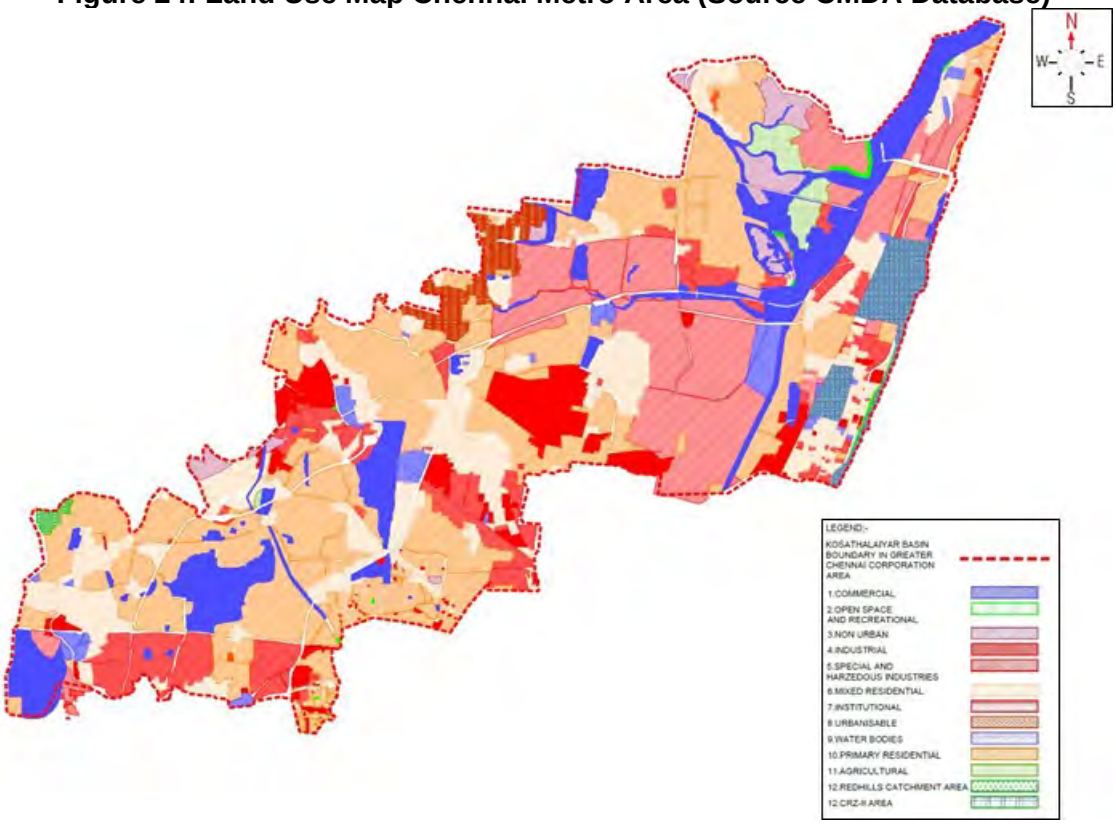


**Table 34: Watershed wise Land use Details**

| Sl. No. | Descriptions | North Ambattur Zone | Korattur Lake Zone | Puzhal South Zone | Retteri Lake Zone | Retteri South Surplus Zone | Captain Cotton Canal West Zone | Puzhal Surplus South Zone | Puzhal Surplus North Zone | North Buckingham canal Zone | North Coast Watershed Zone | Otteri Watershed Zone | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Commercial | 0.0211 | 1.21 | | 0.306 | 0.008 | | 1.633 | | 0.24 | 0.011 | | 3.43 |
| 2 | Open Space & Recreational | | | | 0.005 | 0.009 | | 0.004 | 0.175 | | | | 0.19 |
| 3 | Urbanisable | | | | | | | 0.02 | 2.185 | | | | 2.21 |
| 4 | Non-Urban | | | | 0.417 | 0.037 | | | 2.1404 | | | | 2.59 |
| 5 | Industrial | | 1.48 | | 3.514 | 1.524 | 0.165 | 0.934 | 7.155 | 0.8074 | 1.6703 | 2.27 | 19.52 |
| 6 | Special and Hazardous Industries | | 0.14 | | 0.307 | | | 4.027 | 0.965 | 6.136 | 0.7845 | | 12.36 |
| 7 | Mixed Residential | 0.31 | 0.93 | 0.446 | 2.476 | 1.565 | 0.099 | 9.633 | 1.9643 | 2.8331 | 0.3541 | | 20.61 |
| 8 | Institutional | 0.023 | 0.02 | 0.011 | 0.258 | 0.535 | 0.026 | 3.818 | | 1.081 | | | 5.77 |
| 9 | Water bodies | 1.359 | 3.59 | 0.356 | 2.209 | 0.259 | | 0.959 | 4.526 | 0.335 | 0.1196 | | 13.71 |
| 10 | Primary Residential | 0.336 | 0.95 | 2.555 | 7.537 | 5.499 | | 8.493 | 9.5883 | 4.2785 | 0.9211 | 1.46 | 41.62 |
| 11 | Agriculture | | | | 0.041 | | | | 2.531 | | | | 2.57 |
| 12 | CRZ-II Area | | | | | | | | | 0.919 | 2.2694 | | 3.19 |
| | **Total ($km^2$)** | **2.05** | **8.32** | **3.37** | **17.07** | **9.44** | **0.29** | **29.52** | **31.23** | **16.63** | **6.13** | **3.73** | **127.77** |

## 6. Transport and Traffic

99. There are four types of main roads in the project area that provide regional and local connectivity namely National Highway (NH), State Highway (SH), Major District Roads (MDR) and Other District Roads (ODR).

(i) NH 5 Chennai – Kolkata Highway
(ii) NH 716 Chennai – Tirupathi Highway
(iii) SH 56 – Thiruvottiyur – Ponneri State Highways
(iv) Inner Ring Road (IRR)
(v) Chennai Bypass Road

100. National Highways and State Highways are connected by the internal roads. These include Thiruvottiyur high road, Manali high road, Madhavaram high road, Ennore high road, etc., Sub Urban rail transport exist in Zone 7 (Ambattur) and Zone 1 (Thiruvottiyur). Metro rail proposal from Chennai Airport to Zone 3 Madhavaram is under process. Google Map indicating the major roads and sub urban rail transport in the project area as shown in Figure 25.

**Figure 25: Major Roads in Project Area**


## 7. Water Supply

101. For providing potable water supply to the project area, CMWSSB is operating Water Treatment Plant (WTP) at Kilpauk, Redhills, and Surapattu. Both surface water and groundwater has been sourced to meet the water demand. Information about the WTP's are given in the following table.

**Table 35: Treatment Capacity of Water Treatment Plants**

| Sl No. | Water Treatment Plants | Treatment Capacity (MLD) |
|---|---|---|
| 1 | Kilpauk | 270 |
| 2 | Redhills | 300 |
| 3 | Surapattu | 14 |
| | **Total** | **584** |

102. Piped water supply system exists in Zone I (Thiruvottiyur) and Zone VII (Ambattur) of the project area. In Zone II (Manali) and Zone III (Madavaram) areas, construction of piped water supply system is in progress. (*Source: Tamil Nadu Urban Flagship Investment Program (TNUFIP) - Providing Comprehensive Water Supply Scheme to Mathur, Madipakkam, Jalladampettai and Uthandi in Chennai City*).

### 8. Sewerage System

103. Out of 127.80 km$^2$ of the project area, nearly 96.78 km$^2$ area is covered with the sewerage system (work is commissioned and in operation). For the remaining 31.02 km$^2$, DPR is prepared and ready for execution for 12.14 km$^2$ and DPR is under preparation for an area of 18.88 km$^2$. In Kodungaiyur, 3 STP units having an individual capacity of 110 MLD, 70 MLD and 70 MLD is in operation. In Thiruvottiyur, 31 MLD STP is under construction. Sewerage System status is within the project area, which is presented in Table 36.

**Figure 26: Sewerage System details in the study area**

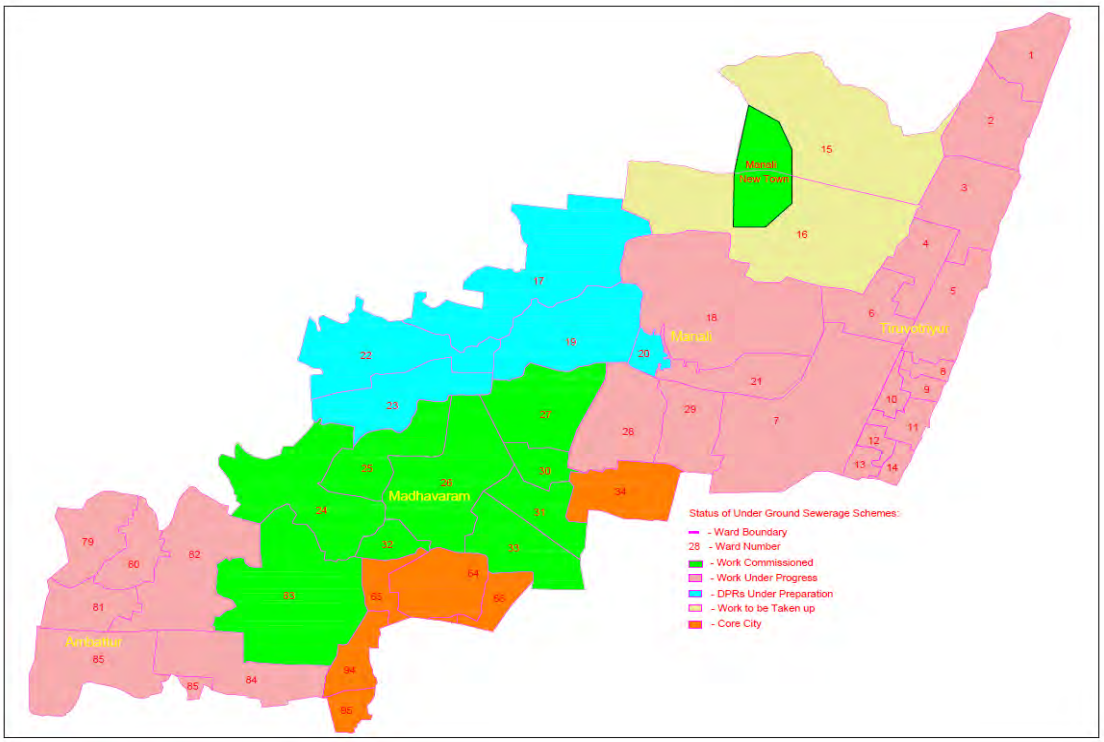


**Table 36: Sewerage System details in the study area**

| Sl No. | Zone No. | Area Name | Area in $km^2$ | UGD Covered Area | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Work to be taken up | Work Commissioned | Work Under Progress | DPR under preparation | Total |
| 1 | Zone I | Thiruvottiyur | 23.57 | | | 23.57 | | 23.57 |
| 2 | Zone II | Manali | 40.47 | 12.14 | | 16.19 | 12.14 | 40.47 |
| 3 | Zone III | Madhavaram | 33.69 | | 26.95 | | 6.74 | 33.69 |
| 4 | Zone VI | Thiru-vi-ka Nagar | 4.15 | | 4.15 | | | 4.15 |
| 5 | Zone VII | Ambattur | 22.82 | | 2.28 | 20.54 | | 22.82 |
| 6 | Zone VIII | Anna Nagar | 3.1 | | 3.10 | | | 3.10 |
| | | **Total** | **127.80** | **12.14** | **36.48** | **60.30** | **18.88** | **127.80** |
| | **Percentage of Coverage** | | | **10%** | **29%** | **47%** | **15%** | **100%** |

### 9. Industry

104. The project area is known for industrial activities; small and medium scale manufacturing industries are functioning in Ambattur Industrial Estate. There are more than 16,940 small scale Industries, notable among them being food, wood, textile, chemical, engineering, non - metallic and leather industries. In Thiruvottiyur, major industries are Chennai Petroleum Corporation Limited (CPCL), Madras Fertilizers Limited (MFL), Toshiba Limited, Manali Petro Chemicals Limited, SRF Limited, Ashok Leyland, Hinduja Foundries, Gulf Lubricants limited, Madras Rubber Factory Limited, etc. The project area also boasts of the Ennore Thermal Power Station and the Avadi Tank Factory. The project area has 16 Industrial Estates, all in operation, of which the Government has developed 11 industrial estates and 5 by Private Organizations. There are 1926 industrial units. These units are further classified into Red, Orange, and Green based on their intensity of pollution. For the disposal of hazardous solid wastes, the TNPCB has identified a landfill site at Manalur.

### 10. Cultural and Heritage sites

105. Project is area is devoid of any notable or important archaeological, historical and/cultural places. There are no protected monuments or places either protected by Archeological Survey of India or by State Archeological Department. The project area does not have any places of notable tourism importance.

### 11. Subproject Site Features

106. Features of the selected subproject sites are presented in the following Table 37:

**Table 37: Subproject Site Features**

| Infrastructure | Location and Environmental Features |
|---|---|
| **Existing Drains to be** | Maya street, Ambattur, Zone-VII, N 13.116567, E 80.157998<br>Mahaveer nagar 4th cross street, Puzhal, Zone-III, N 13.172314, E80.204449 |

| Infrastructure | Location and Environmental Features | |
|---|---|---|
| **demolished and Reconstruction** |  |  |
| | Maya street lies in residential area of Ambattur, Zone-VII and proposed drain will be constructed in the right side of the road. Nearby landmarks are Ambattur Sub Urban Railway station and Chennai bypass road (Perungalathur to Puzhal) exist at a distance of 750m and 660m respectively. There are no environmentally sensitive areas located nearby the proposed drain. | Mahaveer nagar 4th cross street lies in residential area of Puzhal, Zone-III and proposed drain will be constructed in the right side of the road. Nearby landmarks are NH-45 (Guntur Chennai Highway) exist at a distance of 700m. There are no environmentally sensitive areas located nearby the proposed drain. |
| **Existing drains Retained** | TNHB 26th street, Korattur, Zone-VII, N 13.108910, E 80.186407<br>Pattravakkam Aavin diary road, Zone-VII, N1 3.109301, E 80.170422 | |
| |  |  |
| | TNHB 26th street, Korattur, Zone-VII lies in residential area and the drain exist in left side of the road. Nearby landmark of Korattur bus stop exist at a distance of 450m. There are no environmentally sensitive areas located nearby the existing drain. | Pattravakkam Aavin diary road, Zone-VII, exist in SIDCO industrial estate and the drain exist in right side of the road. Nearby landmark of Telephone exchange road exist at a distance of 750m. There are no environmentally sensitive areas located within or nearby the existing drain. |
| **Proposed Drains** | National Highway – 5 (Near Madhavaram), Zone-III; N 13.131906, E80.237519<br>Siva Parvathi Nagar main road, Zone-VI; N13.125566, E80.218956 | |
| |  |  |