

Draft Initial Environmental Examination

Project Number:

March2019

IND: Tamil Nadu Urban Flagship Investment Program –Dedicated Water Supply Scheme for Madurai City Municipal Corporation from Mullai Periyar River at Lower Camp

Abbreviations

| | | |
|---------|---|--|
| ADB | - | Asian Development Bank |
| CMSC | - | Construction Management and Supervision Consultant |
| CPCB | - | Central Pollution Control Board |
| CTE | - | Consent to establishment |
| CTO | - | Consent to Operation |
| EA | - | Executing Agency |
| EAC | - | Expert Appraisal Committee |
| EC | - | Environmental Clearance |
| EHS | - | Environmental Health and Safety |
| EIA | - | Environmental Impact Assessment |
| EMP | - | Environmental Management Plan |
| ES | - | Environmental Specialist |
| ESS | - | Environmental and Social Safeguards |
| GOI | - | Government of India |
| GoTN | - | Government of Tamil Nadu |
| IA | - | Implementing Agency |
| IEE | - | Initial Environmental Examination; |
| MLD | - | Million liters per day |
| MOEF&CC | - | Ministry of Environment, Forest and Climate Change |
| NOC | - | No Objection Certificate |
| OHT | - | Over Head Tank |
| PIU | - | Project Implementation Unit; |
| PMU | - | Project Management Unit |
| PPTA | - | Project Preparatory Technical Assistance |
| REA | - | Rapid Environmental Assessment Checklist |
| RoW | - | Right of Way |
| SEIAA | - | State Environmental Impact Assessment Authority |
| SO | - | Safeguards Officer |
| SPS | - | Safeguard Policy Statement, 2009 |
| TNPCB | - | Tamil Nadu Pollution Control Board |
| TNUFIP | - | Tamil Nadu Urban Flagship Investment Program |
| TNUIFSL | - | Tamil Nadu Urban Infrastructure Financial Services Limited |
| UGT | - | Under Ground Tank |
| WHO | - | World Health Organization |
| WTP | - | Water Treatment Plant |
| WDS | - | Water Distribution Station |

WEIGHTS AND MEASURES

| | |
|-------|---------------------------|
| °C | Degree Celsius |
| km | kilometre |
| lpcd | litres per capita per day |
| m | metre |
| Mgd | million gallons per day |
| MLD | million litres per day |
| mm | millimetre |
| Nos | Numbers |
| sq.km | Square Kilometer |

NOTES

- (i) The fiscal year (FY) of the Government of India and its agencies ends on 31 March.
- (ii) In this report, "\$" refers to US dollars.

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EXECUTIVE SUMMARY

1. The proposed Asian Development Bank (ADB) funded Tamil Nadu Urban Flagship Investment Program (TNUFIP) is aligned to support in the following: (i) urban infrastructure across the state improved and world class cities focusing on universal access to 24x7 water supply services and sanitation facilities including tertiary treatment of sewage to become engines for economic growth developed (Vision 2030, Government of Tamil Nadu, GoTN); (ii) five industrial corridors developed (GoTN Vision 2030); (iii) quality of life for all, especially the poor and the disadvantaged improved (Mission Statement and Guidelines, AMRUT Government of India, 2015); (iv) a clean and sustainable environment provided (Smart Cities - Mission Statement and Guidelines, Government of India, 2015). TNUFIP will focus on cities in five priority economic corridors: Chennai - Hosur, Chennai - Tiruchirapalli, Coimbatore - Madurai, Coimbatore - Salem and Madurai - Thoothukudi. The reform-based component of the program will seek to provide results-based performance incentives to select cities and towns. The program shall also focus on transformative investments in 24X7 water supply, full sanitation coverage smart water management, and urban climate change resilience drawing from the support of various Asian Development Bank (ADB) grant technical assistance.

2. **Components.** The TNUFIP is structured under three main components: (i) investment in municipal infrastructure namely water supply and sewerage, (ii) municipal reform-based activities, and (iii) technical assistance for design, supervision, program management, reforms, and climate change.

3. **The Subproject.** Dedicated Water Supply Scheme for Madurai Municipal Corporation from the Mullai Periyar River at Lower Camp, as source of water is proposed to fulfill the Water Supply demand for the intermediate stage 2034 (for a population of 1,923,936) by tapping 1630 mcft (125 MLD). Already Madurai Corporation is tapping 1500mcft (115MLD) from Vaigai dam, 30 MLD from River Cauvery Source under Melur CWSS and 47 MLD from Vaigai River Bed. The total Water Supply demand gap for Madurai Corporation (100 Wards) in 2034 is estimated to be 125 MLD. There is no nearby reliable source of water to fulfill the total Water Supply demand gap of 125 MLD. Hence, this subproject is proposed to be implemented under the TNUFIP (Tranche -2) to meet the water demand. The subproject includes the construction of Check Dam, Intake arrangements and laying of 1118 mm and 1067 mm MS raw water pumping main to the proposed water treatment plant at Pannaipatti and feeder main and distribution system for 14 water distribution zones of Madurai Corporation.

4. The raw water (125 MLD) will be collected from the proposed Check Dam across Mullai Periyar River at Lower Camp in the immediate downstream of 18th Canal Scheme by providing necessary intake arrangements. The water from the intake well is conveyed through proposed 1118 mm and 1067 mm MS Raw Water Pumping Main to the proposed Water Treatment Plant at Pannaipatti. 130MLD Raw Water Treatment Plant is proposed at Pannaipatti within the site where the existing WTP is located. After treatment, 125 MLD of clear water will be conveyed through clear water Gravity Transmission Main and onwards to the proposed OHTs through a network of proposed feeder mains.

5. **Project implementation arrangements.** The Municipal Administration and Water Supply Department (MAWS) of Government of Tamil Nadu acting through the Tamil Nadu Urban Infrastructure Financial Services Limited (TNUIFSL) is the state-level Executing Agency (EA). A Project Management Unit (PMU) will be established in TNUIFSL headed by

a Project Director and Deputy Project Director (senior official from Commissionerate of Municipal Administration, CMA), and a dedicated full-time staff from TNUIFSL for overall project and financial management. Madurai City Municipal Corporation is the Implementing Agency (IA) for this subproject. A Project Implementation Unit (PIU) will be established in Madurai City Municipal Corporation for day-to-day implementation of the subproject. PIU will be assisted by Construction Management and Supervision Consultant (CMSC). Environmental and Social Safeguards (ESS) Managers in PMU/TNUIFSL will have overall responsibility of safeguard compliance with respect to EMP and EARF. Environmental Specialist of the CMSC will assist PIU in implementation of subproject in compliance with EMP and EARF, and will carry out all necessary tasks.

6. **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 are described in ADB's Safeguard Policy Statement (SPS), 2009. As per the Government of India (GoI) Environmental Impact Assessment (EIA) Notification, 2006, this subproject do not require EIA study or Environmental Clearance. The potential environmental impacts of the subproject have been assessed using ADB Rapid Environmental Assessment (REA) Checklist (**Appendix -1**) for Water Supply. The potential negative impacts were identified in relation to pre-construction, construction and operation phases.

7. **Categorization.**Based on results of the assessment the subproject is classified as Environmental Category "B", Subproject potential adverse environmental impacts are less adverse than those of Category A, and are site-specific, and in most cases mitigation measures can be designed more readily than for Category A projects. As per the ADB SPS 2009, preparation of Initial Environmental Examination (IEE) is mandatory for Category "B" projects and accordingly this IEE has been prepared.

8. **Description of the Environment.**Madurai City is located in the south central Tamil Nadu (470 km from Chennai) and it is the third largest city in Tamil Nadu. Geographically Madurai City is located at 9°55' North and 78°07' East Longitude and 330 feet above sea level on the banks of River Vaigai. The city has an area of 51.80 sq.km. Madurai city experiences soaring heat in the month of May ranging about 38.2°C and a minimum temperature of about 21.0°C in the month of December. The city receives the highest rainfall in the month of October and the lowest in January. The North East monsoon brings a fair amount of rainfall with a maximum of 254.4 mm in October. The major portion of the city soil is red and black. The adjoining area of the city has vernal soil. The city is completely free of forest areas; there are no eco-sensitive areas located within or near the city. On the outskirts of the city, agriculture is followed predominantly. The crops cultivated includes fruits crops like mango, banana and aonla, vegetables like bhendi, gourds, tomato, brinjal, onion and chillies, plantation crops like cashew and betel vine, and flower crops like jasmine and tuberose. As per Census 2011, the population in Madurai city are 18,46,801; of which male and female are 9,25,228 and 9,21,573 respectively. Total literates in Madurai city are 14,85,340 of which 7,77,351 are males while 7,07,989 are females. Average literacy rate of Madurai city is 90.91 %. The sex ratio of Madurai city is 999 per 1000 males. The city is well connected by the National Highways NH 7, NH 45B, NH 208 and NH 49. Madurai Junction is the major railway station serving the city, there are direct trains connecting major cities and towns across India. Madurai Airport located at Avaniyapuram offers domestic flight

services to key cities in India and international services to Middle East and south Asian countries.

9. **Potential environmental impacts and mitigation measures.**The subproject is unlikely to cause significant impacts that are irreversible, diverse or unprecedented because: (i) the components will involve straightforward construction and operation, so impacts will be mainly localized; (ii) there are no significant sensitive environmental features in the project sites although careful attention needs to be paid to minimizing disruption to local population and (iii) predicted impacts are site-specific and likely to be associated with the construction process.

10. Potential impacts that might arise during construction shall be considered as significant but temporary. These impacts of construction are common in urban areas, and there are well-developed methods to mitigate the same. Except laying of conveying main and distribution main, all other construction activities like headwork's, clear water main and water treatment plant will be confined to the selected sites, and the interference with the general public and community around is minimal. In these works, the temporary negative impacts arise mainly from construction dust and noise, hauling of construction material, waste and equipment on local roads (traffic, dust, safety etc.), occupational health and safety aspects. Laying of pipeline will be conducted along the edge of road. Therefore, water pipe laying works will have impacts on the movement of the traffic; safety risk to workers and impediment to public restricting their access, disposal of construction waste, etc. These are all general impacts of construction and there are well-developed methods of mitigation that are suggested in the EMP.

11. **Source Sustainability:**Presently, there are 58 combined and dedicated water supply schemes existing in Mullaperiyar River and Vaigai River between Mullaperiyar Dam (source) and Vaigai Dam (downstream). Total required quantity for 58 existing schemes is 84.80 MLD (35.63cusecs). Drinking water supply demand of Madurai Corporation is 125 MLD (51.09 cusecs). Therefore, total of 209.80 MLD (86.72 cusecs) is required by total 59 drinking water supply schemes between Mullaperiyar Dam and Vaigai Dam.

12. From PWD data, it is observed that average of minimum monthly storage from January 2012 to December 2018 is approximately 1,001 mcft. Details of water release schedule on year-round basis as per Tamil Nadu PWD (Ref.:Lr. No. DB/ JD01/ 384/ C.10 (P)/ 2018, dt.26.12.2018) is shown in Table below. Required quantity for Madurai Corporation is scheduled as continuous release for drinking water supply requirements.

Water Release Schedule from Mullaperiyar Dam

| No. | Description | Demand Type | Duration | Water Release |
|-----|--------------------------------------|-----------------------|------------------------------|---------------|
| | EXISTING | | | <u>cusecs</u> |
| 1 | Cumbum Valley Irrigation Scheme | Irrigation | 240 days on or after June 01 | 200.00 |
| 2 | PT Rajan Channel | Irrigation | 100 days after Oct 01 | 100.00 |
| 3 | Theni District(58 Schemes - Table 1) | Drinking Water | Year Round | 100.00 |
| | PROPOSED | | | |
| 4 | Madurai Corporation Scheme | Drinking Water | Year Round | 51.09 |

Source: PWD, GoTN

13. Therefore, year round demand for drinking water supply of 151.09 cusecs per day works out to monthly requirement of approximately 391.65 mcft per month.Since average value of minimum monthly storage of Mullaperiyar Dam from January 2012 to December

2018 is 1,001 mcft per month and also drinking water supply is given highest priority in National Water Policy and State Government, it is concluded that Mullaperiyar Dam source is sustainable for proposed Madurai Water Supply Improvement Scheme of Madurai Corporation.

14. **Environmental Management Plan.** An Environmental Management Plan (EMP) has been developed to provide mitigation measures to reduce all negative impacts to acceptable levels, along with the delegation of responsibility to appropriate agency. As stated above, various design related measures are already included in the project design. During construction, the EMP includes mitigation measures such as (i) proper planning of pipe laying works to minimize the public inconvenience (ii) barricading, dust suppression and control measures (iii) traffic management measures for works along the roads and for hauling activities; (iv) provision of walkways and planks over trenches to ensure access will not be impeded; and (v) finding beneficial use of excavated materials to extent possible to reduce the disposal quantity. EMP will guide the environmentally - sound construction of the subproject. EMP includes a monitoring program to measure the effectiveness of EMP implementation and include observations on- and off-site, document checks, and interviews with workers and beneficiaries.

15. The EMP will be included in the bid and contract documents to ensure compliance to the conditions set out in this document .The contractor will be required to submit to PIU, for review and approval, a Site Environmental Management Plan (SEMP) including (i) proposed sites/locations for construction work camps, storage areas, hauling roads, lay down areas, disposal areas for solid and hazardous wastes; (ii) specific mitigation measures following the approved EMP; and (iii) monitoring program as per EMP. No works are allowed to commence prior to approval of SEMP. A copy of the EMP/approved SEMP will be kept on site during the construction period at all times.

16. **Consultation, Disclosure and Grievance Redress Mechanism.** The stakeholders were involved in developing the IEE through discussions on-site and a public consultation workshop at project area level, after which views expressed were incorporated into the IEE and in the planning and development of the project. The IEE will be made available at public locations and will be disclosed to a wider audience via the ADB, Madurai Municipal Corporation and TNUIFSL websites. The consultation process will be continued during project implementation as required. A Grievance Redress Mechanism (GRM) is described within the IEE to ensure any public grievances are addressed quickly.

17. **Monitoring and Reporting.** Contractor will submit a monthly EMP implementation report to PIU. PIU with the assistance of CMSC will monitor the compliance of Contractor, prepare a Quarterly Environmental Monitoring Report and submit to PMU. The PMU will oversee the implementation and compliance, and will submit semi-annual monitoring reports to ADB. ADB will post the environmental monitoring reports on its website. Monitoring reports will also be posted on Madurai City Municipal Corporation and TNUIFSL websites.

18. **Conclusions and Recommendations.** Therefore, as per ADB SPS, the project is classified as Environmental Category 'B' and does not require further environmental impact assessment. However, to conform with the government guidelines Water Treatment Plant requires Consent to Establishment (CTE) and Consent to Operate (CTO) from Tamil Nadu Pollution Control Board (TNPCB), which shall be obtained for the WTP prior to construction and operation, respectively. This IEE shall be updated by PIU in Madurai Municipal

Corporation during the implementation phase to reflect any changes, amendments and will be reviewed and approved by PMU.

I. INTRODUCTION

A. Background

19. The proposed Asian Development Bank (ADB) funded Tamil Nadu Urban Flagship Investment Program (TNUFIP) is aligned to support in the following: (i) urban infrastructure across the state improved and world class cities focusing on universal access to 24x7 water supply services and sanitation facilities including tertiary treatment of sewage to become engines for economic growth developed (Vision 2030, Government of Tamil Nadu, GoTN); (ii) five industrial corridors developed (GoTN Vision 2030); (iii) quality of life for all, especially the poor and the disadvantaged improved (Mission Statement and Guidelines, AMRUT Government of India, 2015); (iv) a clean and sustainable environment provided (Smart Cities - Mission Statement and Guidelines, Government of India, 2015). TNUFIP will focus on cities in five priority economic corridors: Chennai - Hosur, Chennai - Tiruchirapalli, Coimbatore - Madurai, Coimbatore - Salem and Madurai - Thoothukudi. The reform-based component of the program will seek to provide results-based performance incentives to select cities and towns. The program shall also focus on transformative investments in 24X7 water supply, full sanitation coverage smart water management, and urban climate change resilience drawing from the support of various Asian Development Bank (ADB) grant technical assistance.

20. **Components:** The TNUFIP is envisaged to be structured under three main components: (i) investment in Municipal infrastructure namely Water supply and Sewerage, (ii) Municipal reform-based activities, and (iii) Technical Assistance for design, supervision, program management, Reforms, and Climate change.

21. **Impact and outcome:** TNUFIP will be implemented over an 8-year period beginning in 2018, and will be funded by ADB via its multi tranche financing facility (MFF). The impact of the TNUFIP will be improved livability and resilience in urban areas of economic importance in Tamil Nadu. The outcome of TNUFIP will be smart and climate resilient urban services delivered in priority industrial corridors in Tamil Nadu:

- (i) **Output 1: Sewage collection and drainage improved and climate friendly sewage treatment systems introduced.** This will include (i) new and rehabilitated sewage treatment capacity developed with clean energy solar photo-voltaic (PV) installed on a pilot basis; (ii) reuse of treated sewage water for industrial purposes in suitable areas; (iii) new and improved sewage collection pipelines constructed with household connections made; (iv) new sewage pumping capacity added; (v) community water and sanitation committees formed with female participation; and (vi) drainage and flood management systems established.
- (ii) **Output 2: Access to reliable and smart drinking water services improved.** This will include the development of (i) smart water supply distribution systems within new district metering areas to reduce non-revenue water and provide regular water supply; (ii) new transmission mains; and (iii) new water storage reservoirs.
- (iii) **Output 3: Institutional capacity, public awareness, and urban governance strengthened.** This will include (i) establishing a new state-level urban data and governance improvement cell in the Commissionerate of Municipal Administration (CMA); (ii) establishing a new project design and management center in CMA; (iii) implementing a performance-based grant incentive urban governance program for ULBs to improve in areas of financial management, municipal revenues,

administration, service delivery, and gender mainstreaming; and (iv) implementing public awareness campaigns in water conservation, sanitation, and hygiene. Project Design Consultants will be recruited to prepare new projects including: (i) feasibility studies; (ii) surveys and investigations; (iii) engineering design of projects; (iv) preparation of bidding documents; and (v) safeguard assessment.

B. Scope of Project

22. The Madurai Municipal Corporation drinking water need is being managed with the allotted quantity of 1500 MCFT (115 MLD) at Vaigai Dam, 30 MLD from River Cauvery Source under Melur CWSS and 29 MLD from Vaigai River Bed. The Intermediate water supply demand for 2034 with the population of 19,23,936 is estimated to be 317 MLD including 15% transmission losses. From all existing sources, the designed quantity of water available is only 174 MLD. The water supply demand gap for 2034 is 125 MLD. To meet out the demand gap of 125 MLD the Madurai Municipal Corporation has analysed the possibilities of drawl of water from Mullai Periyar River at Lower camp through closed conduits.

- In G.O.No.872, Public Works Department Dated. 04.06.1985 Government has allotted 1500 MCFT from Vaigai Dam, through this 115 MLD quantity of water is being drawn every day. There is a huge gap between available quantity and demand.
- Vaigai Dam receives water mainly from Mullai Periyar River. During summer 200 cusecs of water is being released for Water Supply Demand of Theni & Madurai Districts. The head works in the upstream side of Vaigai Dam are tapping 100 cusecs of water for the local bodies in the Theni District but due to evaporation and percolation of loss the remaining 100 cusecs is not reaching Vaigai Dam, only 40 cusecs are reaching Vaigai Dam. Hence, to avoid evaporation percolation losses, it is proposed to draw 125 MLD of water from Mullai Periyar River at Lower Camp through closed conduits.
- The water will be collected by accumulating it through the construction of a Check Dam across Mullai Periyar River at Lower Camp in the immediate downstream of 18th Canal Scheme by providing necessary intake arrangements. The water from the intake well is conveyed through newly proposed 1422mm MS Raw Water Pumping Main to the newly proposed Water Treatment Plant (WTP) at Pannaipatti.
- 125MLD Raw Water Treatment Plant is proposed at Pannaipatti in the same place where the existing WTP is located.
- After treatment, 125 MLD of clear water is conveyed through clear water Gravity Transmission Main to Madurai Corporation.
- Then the water is conveyed through proposed Feeder mains to the newly proposed service reservoirs for proper distribution to the beneficial use.
- Distribution system to few areas under Madurai Corporation is proposed under this project.

23. The Government has allotted 8.97 MLD of water from Melur CWSS for Madurai Corporation. The allotted quantity is tapped at LS 1560 m of Feeder main to Melur Municipality in Alagar koil - Melur Road and conveyed to Madurai Corporation for beneficial use.

C. Purpose of this IEE Report

24. ADB requires the consideration of environmental issues in all aspects of the Bank's operations, and the requirements for environmental assessment are described in ADB's

Safeguard Policy Statement (SPS), 2009. The potential environmental impacts of the subproject have been assessed using ADB Rapid Environmental Assessment Checklist for Water Supply (**Appendix 1**). The potential negative impacts were then identified in relation to pre-construction, construction and operation of the improved infrastructure, and results of the assessment show that the subproject is unlikely to cause significant impacts. Thus, this initial environmental examination (IEE) has been prepared in accordance with ADB SPS's requirements for Environment Category 'B' projects.

25. The IEE is prepared based on the Detailed Project Report (DPR)¹, field reconnaissance surveys and secondary sources of information. No field monitoring (environmental) survey was conducted, however, the environmental monitoring program developed as part of the Environmental Management Plan (EMP) require the contractors 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 subproject implementation. Stakeholder consultation was an integral part of the IEE.

D. Structure of the Report

26. This Report contains the following ten(10) sections including the Executive Summary at the beginning of the report:

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

¹ prepared by Madurai City Municipal Corporation (MCMC)

II.

II. DESCRIPTION OF THE PROJECT

A. Project Area

27. Madurai City, located in south central Tamil Nadu, is the third largest city after Coimbatore. The total population is around 18.47lakh (as per 2011 census) and is the headquarters of Madurai District. The city is well connected by road and railway network to the urban centers in the state and the neighboring states. The Madurai City Municipal Corporation (MCMC) administers the city with the administrative jurisdiction extending over an area of 147 sq. km.

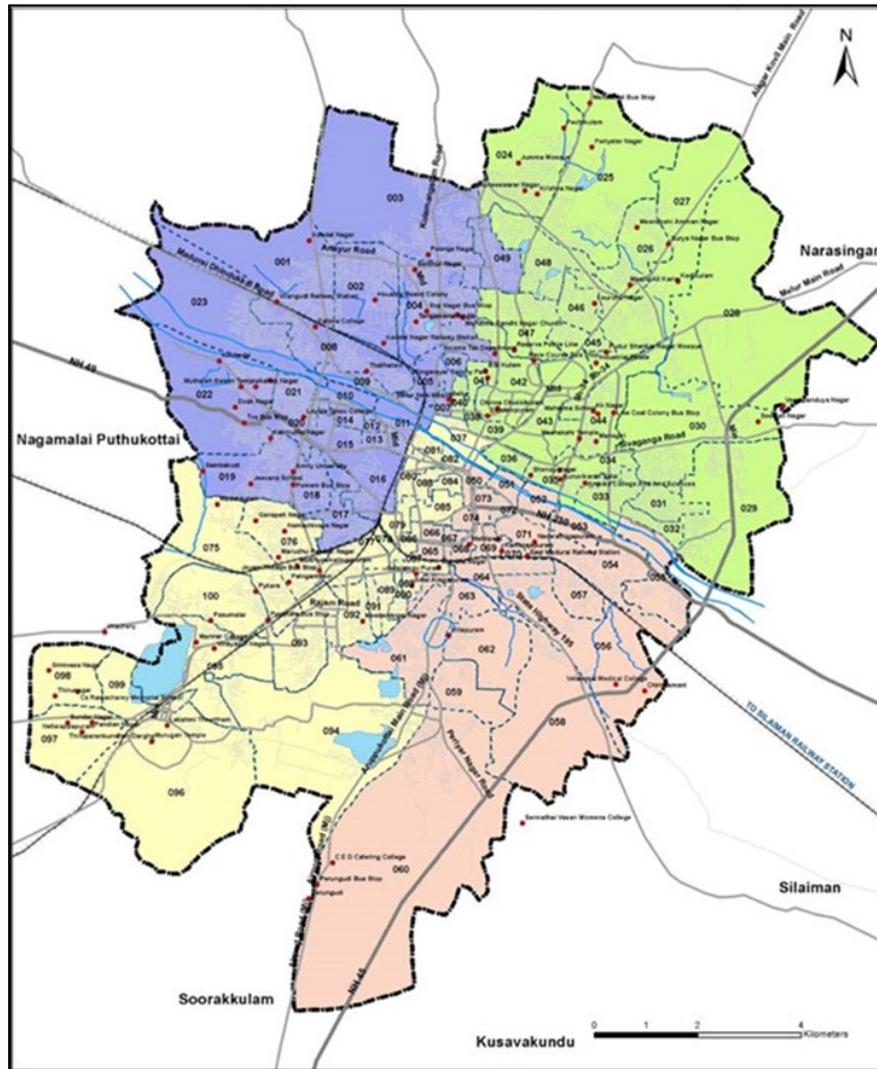


Figure 1: Madurai City Map

B. Existing Water Supply System

28. **General:** The core city of Madurai Municipal Corporation consists of 100 wards (including the added area of 28 Wards). The existing water supply Schemes are functioning separately for core area and added area of Madurai City Municipal Corporation. The details of existing water supply Schemes (distribution system covering 52 sq. km area) are discussed in the following sections.

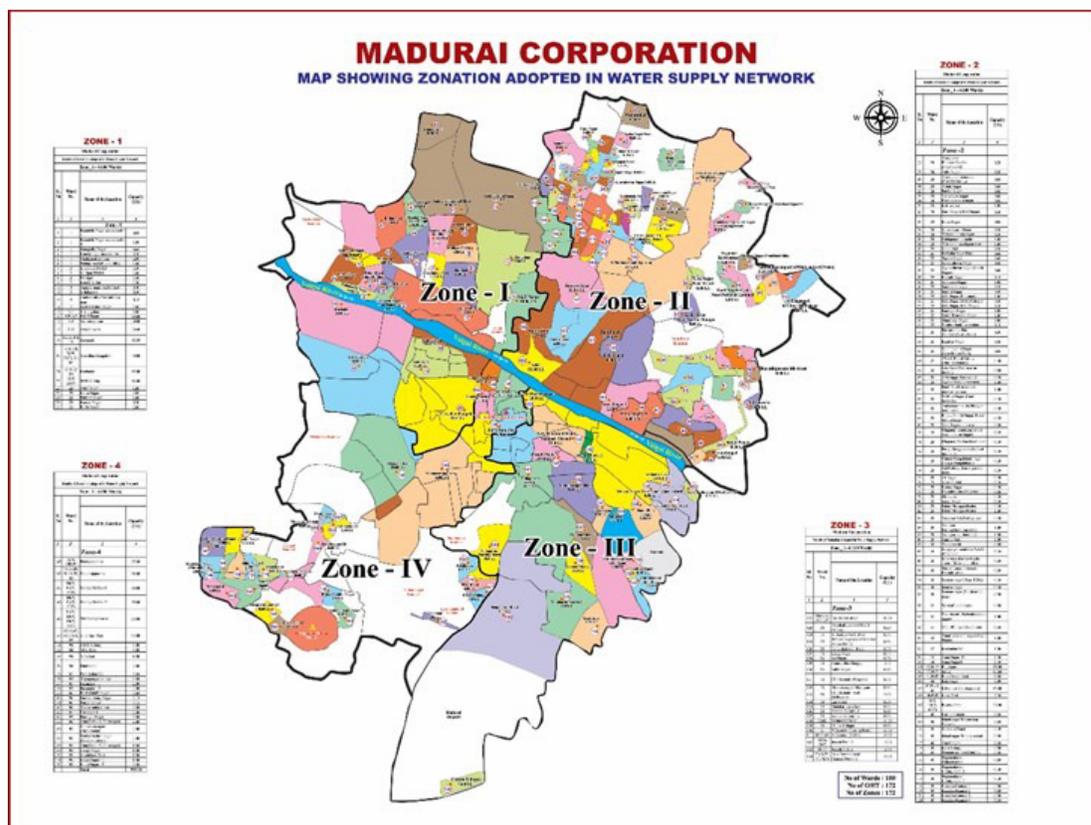


Figure 2: Water supply zones of Core Madurai

29. **Main Source of Water:** The main source of water supply for Core City of Madurai City Municipal Corporation is Vaigai Dam. The total storage capacity of Vaigai Dam is 6,091 MCFT. Vaigai Dam Reservoir is primarily intended to meet the irrigation requirements of southern districts in Tamil Nadu, Apart from providing water supply to Madurai, other wayside towns such as Usilampatti, Nilakottai, Sholavandhan, Vathalagundu and many villages are also benefited through the water supply schemes from River Vaigai. The main source of water to Vaigai Dam is the release of surplus water from Mullai Periyar Dam. The details of the Vaigai dam and the Mullai Periyar Dam are given in the following tables.

Table 1: Vaigai Dam Water Levels

| Sl. No. | Vaigai Dam | | |
|---------|------------|---------------|---------------|
| | Year | Maximum Level | Minimum Level |
| 1 | 1993 | 69.75 | 69.24 |
| 2 | 1994 | 69.50 | 48.65 |
| 3 | 1995 | 58.15 | 35.95 |
| 4 | 1996 | 57.30 | 27.70 |
| 5 | 1997 | 70.40 | 22.15 |
| 6 | 1998 | 69.95 | 49.20 |
| 7 | 1999 | 70.20 | 57.20 |
| 8 | 2000 | 63.10 | 44.70 |
| 9 | 2001 | 63.55 | 52.35 |

| Sl. No. | Vaigai Dam | | |
|---------|------------|---------------|---------------|
| | Year | Maximum Level | Minimum Level |
| 10 | 2002 | 52.25 | 24.00 |
| 11 | 2003 | 54.10 | 22.60 |
| 12 | 2004 | 60.95 | 24.23 |
| 13 | 2005 | 66.84 | 25.34 |
| 14 | 2006 | 67.90 | 44.88 |
| 15 | 2007 | 64.11 | 28.35 |
| 16 | 2008 | 70.93 | 56.09 |
| 17 | 2009 | 62.09 | 26.01 |
| 18 | 2010 | 69.21 | 26.25 |
| 19 | 2011 | 67.76 | 46.09 |
| 20 | 2012 | 66.08 | 33.67 |
| 21 | 2013 | 57.05 | 34.66 |
| 22 | 2014 | 70.33 | 21.06 |

Source: Madurai Corporation

Table 2: Details of Periyar Dam

| Periyar Dam | |
|--------------------------|---|
| Coordinates | 9°31'43"N 77°8'39"E |
| Opening date | 1895 |
| Dam and spillways | |
| Type of dam | Gravity |
| Impounds | Periyar River |
| Height (foundation) | 53.66 m (176 ft) |
| Length | 365.85 m (1,200 ft) (main) |
| Width (crest) | 3.6 m (12 ft) |
| Width (base) | 42.2 m (138 ft) |
| Spillways | 13 |
| Spillway capacity | 3,454.62 cubic metres per second |
| Reservoir | |
| Total capacity | 443,230,000 m ³ (359,332 acre-ft) |
| Active capacity | 299,130,000 m ³ (242,509 acre-ft) ^[4] |
| Max. water depth | 43.281 m (142 ft) |

Source: Madurai Corporation

30. **Allocation of water from Mullai Periyar at Lower Camp:** Nearly 100 cusecs of water can be drawn from the check dam located in the downstream of Mullai Periyar River. By considering the water demand of 35 cusec (including the evaporation loss of 7 cusecs (20 %)) for the Theni local bodies, the remaining available water would be around 58 cusecs, However, for the proposed water supply scheme, it requires only 50 cusecs which shall be drawn from the available water. Month wise details on Average storage, average discharge, quantity given for drinking water, irrigation purpose are tabulated and given below.

Table 3: Periyar Dam - Storage, Discharge for Drinking Water & Irrigation

| Sl.No. | Name of the Year | Average Storage (in Mcft) | Average Discharge per day (in cusec) | Discharge for Drinking Water Purpose per day (in cusec) | Discharge for Irrigation Purpose per day (in cusec) | Total Release of water for Irrigation Purpose per year (in mcft) |
|--------|--------------------------|---------------------------|--------------------------------------|---|---|--|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | 2013 | 2339.96 | 672.05 | 103.59 | 568.46 | 17926.96 |
| 2 | 2014 | 2938.37 | 697.81 | 102.61 | 595.20 | 18770.14 |
| 3 | 2015 | 2839.86 | 663.56 | 105.11 | 558.45 | 17611.43 |
| 4 | 2016 | 1867.10 | 407.05 | 104.29 | 302.75 | 9547.63 |
| 5 | 2017 | 1791.78 | 440.96 | 100.07 | 341.01 | 10752.27 |
| 6 | 2018 (as on 31.07.18) | 2260.39 | 559.72 | 98.85 | 460.87 | 8441.71 |

Note:

1) In Column 3 the average storage of water at Periyar Dam is calculated. The month wise average storage of the Dam is enclosed for reference.

2) In Column 4 average discharge from Mullai Periyar Dam is calculated. The month wise average discharge of the Dam is enclosed for reference.

3) In Column 5 average drawal of water for drinking water purpose from the total average discharge is calculated (assuming that an average of 100 cusec is being drawn for drinking water purpose). The month wise average drawl from the total average discharge is enclosed.

4) In Column 6 average drawal of water for irrigation purpose from the total average discharge is calculated. The month wise average drawal from the total average discharge is enclosed.

5) In Column 7 total quantity of water released for irrigation purpose in a year in mcft.

31. **Storage of water in dam before and after judgment of Supreme Court:** The water storage level in the Mullai periyar dam before the court judgment is 136 ft. After the court judgment to regarding increasing the storage level it has been increased from 136 ft to 142 ft (Hon'ble Supreme Court Judgment in original suit no. 3 of 2006 in page no. 97 – paragraph no. 122.9), due to increase in the storage level 1598 MCFT can be stored in the dam. The circulation and evaporation loss is calculated as 20 % of the released quantity.

32. **Stability of the Mullai Periyar Dam:** Hon'ble Supreme Court Judgment in original suit no. 3 of 2006 in page no. 99 – paragraph no. 126 clear order has been given by the experts "The obstruction by Kerala to the water level in the Mullai Periyar Dam being raised to 142 Ft. on the ground of safety was found untenable, and in its judgment, this court so pronounced". The Supreme Court has passed the judgment after getting the details technical report from the expert committee appointed by Supreme Court. The committee appointed by Supreme Court is examining the stability of the dam continuously interpreting or inferring the SC order is not possible. A separate note based on Supreme Court. Order on dam safety and related aspects has been attached as **Appendix 11**.

33. **The Source Sustainability:** Proposal is to augment and improve Water Supply system in Madurai City Municipal Corporation with Mullaperiyar Dam as source. Scheme is designed to draw 125 MLD (Intermediate Stage 2034) from Mullaperiyar Dam at Lower

Camp, raw water transmission to WTP at Pannaipatti and clear water shall be conveyed to 56 Overhead tanks by gravity flow.

34. Water Utilisation Committee of Government of Tamil Nadu (Ref. G.O.4D No.6 dated 23.07.2018 of Public Works (W2) Department) has approved water supply proposal for 125 MLD drawal from intake works at Lower Camp, Cumbum.

35. Presently, there are 58 combined and dedicated water supply schemes existing in Mullaperiyar River and Vaigai River between Mullaperiyar Dam (source) and Vaigai Dam (downstream). Total required quantity for 58 existing schemes is 84.80 MLD (35.63cusecs). Drinking water supply demand of Madurai Corporation is 125 MLD (51.09 cusecs). Therefore, total of 209.80 MLD (86.72 cusecs) is required by total 59 drinking water supply schemes between Mullaperiyar Dam and Vaigai Dam. Details shown in Table 4.

Table 4: Drinking Water Supply Schemes in Mullaperiyar and Vaigai River from Mullaperiyar Dam up to Vaigai Dam

| No. | Name of Scheme | O&M Agency | Head works Location | Type of WS Scheme | Scheme Capacity (MLD) |
|--|--|------------|----------------------------------|-------------------|-----------------------|
| PERIYAR AND VAIGAI RIVER | | | | | |
| A). AT LOWER CAMP | | | | | |
| 1 | Madurai Corporation | ULB | Lower Camp | Dedicated | 125.00 |
| Total I | | | | | 125.00 |
| B). FROM LOWER CAMP TO VAIGAI DAM | | | | | |
| 2 | CWSS TO CUMBUM ValleyTown | TWAD | At Lower camp | CWSS | 14.03 |
| 3 | Kombai – Thevaram - Pannaipuram CWSS (new) | TWAD | Downstream of Periyar Powerhouse | CWSS | 2.70 |
| 4 | C. Pudupatty T.P. WSIS | TWAD | Downstream of Periyar Powerhouse | CWSS | 6.94 |
| 5 | Kombai -Thevaram-Pannaipuram CWSS (new) | TWAD | Downstream of Periyar Powerhouse | CWSS | 3.45 |
| 6 | Kullappagoundanpatty & Kamayagoundanpatty CWSS | LB | K.G.Patty | Dedicated | 2.00 |
| 7 | Kullappagoundanpatty & Kamayagoundanpatty CWSS | LB | At Surulipatty | CWSS | 0.14 |
| 8 | Surulipatty WSS | LB | At Surulipatty | Dedicated | 0.48 |
| 9 | Naarayanathevanpatty CWSS | LB | At Surulipatty | Dedicated | 0.48 |
| 10 | Rayappanpatty WSS | LB | At Surulipatty | Dedicated | 0.24 |
| 11 | Anamalaiyanpatty WSS | LB | Anamalaiyanpatty | Dedicated | 0.23 |
| 12 | Kohilapuram CWSS | TWAD | Anamalaiyanpatty | CWSS | 0.85 |
| 13 | Odaipatty CWSS | TWAD | u/s Uthamapalayam weir | CWSS | 2.11 |
| 14 | Ambasamudram WSS (Near Ammapatty) | LB | Ambasamudram | Dedicated | 0.05 |
| 15 | Ampapatty WSS | LB | Near Ammapatty | Dedicated | 0.16 |
| 16 | Chinnamanur Mpty WSIS | LB | West of Chinnamanur Mpty | Dedicated | 1.92 |
| 17 | Markayankottai and Ellaipatty | LB | U/s Markayankottai bridge | CWSS | 0.28 |
| 18 | Odaipatty TP | LB | U/s Markayankottai bridge | Dedicated | 1.94 |
| 19 | T.Sindalacherry CWSS | TWAD | D/s Markayankottai bridge | CWSS | 1.40 |

| No. | Name of Scheme | O&M Agency | Head works Location | Type of WS Scheme | Scheme Capacity (MLD) |
|-----|----------------------------------|------------|-----------------------------|-------------------|-----------------------|
| 20 | Kamatchipuram CWSS | TWAD | U/S Kutchanur weir | CWSS | 1.10 |
| 21 | Sankarapuram CWSS | TWAD | U/S Kutchanur weir | CWSS | 1.60 |
| 22 | Veppampatty CWSS | TWAD | U/S Kutchanur weir | CWSS | 1.20 |
| 23 | Seelayampatty | LB | U/S Kutchanur weir | Dedicated | 0.36 |
| 24 | Kutchanur WSS | LB | U/S Kutchanur weir | Dedicated | 0.63 |
| 25 | Kottur | LB | Kottur | Dedicated | 0.36 |
| 26 | B.Meenakshipuram | LB | At Uppukkottai | Dedicated | 0.77 |
| 27 | Kundalnaickenpatty WSS | LB | Kundalanaicken patty | Dedicated | 0.24 |
| 28 | Upparpatty WSS | LB | Kundalanaicken patty | Dedicated | 0.13 |
| 29 | DombuCherry | LB | Kundalanaicken patty | CWSS | 0.24 |
| 30 | Melachokkanathapuram TP WSIS | LB | Kondalnaicken patty | Dedicated | 1.57 |
| 31 | INO WSS | TWAD | Kondalnaicken patty | Dedicated | 0.40 |
| 32 | Kamarajapuram CWSS | TWAD | U/S Uppukottai weir | CWSS | 0.70 |
| 33 | Sillamarathupatty CWSS | TWAD | U/S Uppukottai weir | CWSS | 1.70 |
| 34 | Govindanagaram CWSS | TWAD | U/S Uppukottai weir | CWSS | 2.15 |
| 35 | Veerapandy TP | LB | U/s Veerapandy Bridge | Dedicated | 1.33 |
| 36 | Veerapandy TP WSIS | LB | Veerapandi | Dedicated | 1.00 |
| 37 | Palanichetty patty WSIS | LB | U/s Veerapandy Bridge | Dedicated | 1.02 |
| 38 | Palanichetty patty TP WSIS | LB | Veerapandi | Dedicated | 2.00 |
| 39 | Kodangipatty | LB | D/sVeerapandy | CWSS | 0.24 |
| 40 | Manjanaickenpatty | LB | D/sVeerapandy | CWSS | 0.24 |
| 41 | Thadicherry CWSS | TWAD | U/S Palanichetty patty weir | CWSS | 1.40 |
| 42 | Palanichetty patty WSS | LB | U/S Palanichetty patty weir | Dedicated | 0.82 |
| 43 | Aranmanaipudur | LB | U/S Palanichetty patty weir | Dedicated | 0.24 |
| 44 | Aranmanaipudur WSS | LB | U/S Palanichetty patty weir | Dedicated | 0.24 |
| 45 | Kandamanur & 15 Habitations | CWSS | U/S Palanichetty patty weir | TWAD | 0.88 |
| 46 | Pandian sericulture | Private | Palanichetty patti | Dedicated | 0.03 |
| 47 | Theni Municipality WSS(1 and 2) | LB | Palanichetty patti | Dedicated | 4.29 |
| 48 | Kottaipatty & Mariyayipatty CWSS | LB | Kottaipatty | Dedicated | 0.24 |
| 49 | Palakombai CWSS | TWAD | Near Kunnur | CWSS | 2.13 |
| 50 | Vallalnathi CWSS | TWAD | Downstream of Kunnur bridge | CWSS | 1.61 |
| 51 | Theni Collector Complex WSS | | Downstream of Kunnur bridge | Dedicated | 0.24 |
| 52 | Theni Collector Bungalow WSS | PWD | Downstream of Kunnur bridge | Dedicated | 0.24 |
| 53 | Theni Medical college | Private | Arapadidevanpatti | Dedicated | 0.56 |
| 54 | Unjampatty-WSS | LB | Downstream of Kunnur bridge | Dedicated | 0.50 |
| 55 | Unjampatty- Vadapudupatty | TWAD | Downstream of | CWSS | 0.58 |

| No. | Name of Scheme | O&M Agency | Head works Location | Type of WS Scheme | Scheme Capacity (MLD) |
|---------------------------|--|------------|--------------------------|-------------------|-----------------------|
| | CWSS | | Kunnur bridge | | |
| 56 | Andipatty rural CWSS (Arapadithevanpatty CWSS) | TWAD | Downstream Kunnur bridge | of CWSS | 1.48 |
| 57 | Andipatty UTP WSS | LB | Downstream Kunnur bridge | of Dedicated | 2.30 |
| 58 | Theni Municipality WSS | LB | Downstream Kunnur bridge | of Dedicated | 8.64 |
| Total II | | | | MLD | 84.80 |
| Grand Total (I+II) | | | | MLD | 209.80 |
| | | | | Cusecs | 86.72 |

36. Honorable Supreme Court (SC) of India through Order in W.P. (C) No. 386/2001dt. 27.2.2006 and subsequently through Order dated May 07, 2014 "Original Suit No.3 of 2006" permitted Govt. of Tamil Nadu to raise the water level from 136.00 ft. to 142.00 ft. and ultimately to 152.00 ft. after completion of further strengthening measures on the Mullaperiyar Dam.

37. Based on Tamil Nadu PWD, at storage level of 142.00 ft. as allowed by S.C. Order, available useful storage capacity is 7,666 mcft against total storage capacity of 12,758 mcft. Monthly average storage in Mullaperiyar Dam for past 7 years is shown in Table 5.

Table 5: Monthly Average Storage in Mullaperiyar Dam (January 2012 to December 2018)

| Year | Monthly Average Storage (MCFT) | | | | | | | | | | | |
|------|--------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| 2012 | 1,932 | 919 | 810 | 1,005 | 917 | 1,083 | 1,063 | 1,687 | 2,278 | 2,128 | 2,367 | 1,683 |
| 2013 | 1,327 | 1,026 | 1,364 | 1,288 | 1,289 | 2,042 | 3,607 | 5,135 | 3,443 | 2,559 | 2,076 | 2,119 |
| 2014 | 1,623 | 1,021 | 1,242 | 1,070 | 1,590 | 1,536 | 1,883 | 3,349 | 4,722 | 4,364 | 6,788 | 5,488 |
| 2015 | 3,034 | 1,456 | 1,168 | 1,200 | 1,884 | 2,267 | 3,559 | 2,497 | 1,962 | 2,262 | 4,937 | 7,330 |
| 2016 | 5,044 | 2,452 | 1,285 | 970 | 993 | 1,100 | 2,278 | 2,284 | 1,508 | 912 | 958 | 1,177 |
| 2017 | 953 | 884 | 917 | 877 | 766 | 755 | 1,142 | 1,497 | 3,260 | 2,918 | 3,045 | 3,914 |
| 2018 | 2,187 | 1,599 | 1,317 | 1,316 | 1,342 | 3,190 | 4,660 | 6,478 | 4,561 | 5,241 | 4,625 | 4,099 |

Source- PWD, Note: Monthly storage based on "average of daily storage level readings".

38. Minimum, maximum and mean values are also computed and shown in Table 6.

Table 6: Abstract of Monthly Storage of Mullaperiyar Dam - January 2012 to December 2018

| No. | Year | Monthly Storage (MCFT) | | |
|--|------|------------------------|-----------------|-----------------|
| | | Minimum | Maximum | Average |
| 1 | 2012 | 810.48 | 2,366.58 | 1,489.35 |
| 2 | 2013 | 1,025.94 | 5,134.61 | 2,272.91 |
| 3 | 2014 | 1,021.42 | 6,788.13 | 2,889.58 |
| 4 | 2015 | 1,168.13 | 7,330.16 | 2,796.46 |
| 5 | 2016 | 911.90 | 5,043.77 | 1,746.77 |
| 6 | 2017 | 755.23 | 3,914.23 | 1,743.98 |
| 7 | 2018 | 1,316.20 | 6,477.84 | 3,384.59 |
| Average of Monthly Average Values | | 1,001.33 | 5,293.62 | 2,331.95 |

39. Based on above, it is observed that average of minimum monthly storage from January 2012 to December 2018 is approximately 1,001 mcft. Details of water release schedule on year-round basis as per Tamil Nadu PWD (Ref.:Lr. No. DB/ JD01/ 384/ C.10 (P)/ 2018, dt.26.12.2018) is shown in **Table 7**. Required quantity for Madurai Corporation is scheduled as continuous release for drinking water supply requirements.

Table 7: Water Release Schedule from Mullaperiyar Dam

| No. | Description | Demand Type | Duration | Water Release |
|----------|--------------------------------------|-----------------------|------------------------------|---------------|
| | EXISTING | | | <u>cusecs</u> |
| 1 | Cumbum Valley Irrigation Scheme | Irrigation | 240 days on or after June 01 | 200.00 |
| 2 | PT Rajan Channel | Irrigation | 100 days after Oct 01 | 100.00 |
| 3 | Theni District(58 Schemes - Table 1) | Drinking Water | Year Round | 100.00 |
| | PROPOSED | | | |
| 4 | Madurai Corporation Scheme | Drinking Water | Year Round | 51.09 |

Source: PWD, GoTN

40. Therefore, year round demand for drinking water supply of 151.09 cusecs per day works out to monthly requirement of approximately 391.65 mcft per month. Since average value of minimum monthly storage of Mullaperiyar Dam from January 2012 to December 2018 is 1,001 mcft per month and also drinking water supply is given highest priority in National Water Policy and State Government, it is concluded that Mullaperiyar Dam source is sustainable for proposed Madurai Water Supply Improvement Scheme of Madurai Corporation.

41. **Existing Water Supply Schemes in Core City of Madurai Corporation:** The first protected water supply was provided to Madurai City in the year 1892, through head works at Aarapalayam. Subsequently, considering the increasing population and additional demand, the augmentation for the city supply has been implemented in the years 1924, 1963, 1973, 1985, 1987, 1995 and 2009 respectively.

Table 8: Details of Head Works

| S.No. | Components | Description |
|------------------------------|--|--|
| 1 | Kochadai Head works | |
| | Type | Infiltration Gallery |
| | Year of construction | 1924 |
| | Year of Improvement | 1940 |
| | Distance from the town | 7.00 km. |
| | Motor HP | 170 HP |
| | Pump Duty | Centrifugal, 3,000 GPM (13620 lpm) @ 85 ft (25.91 m) Head |
| | Length of Infiltration Gallery | 218.29 m across the river; 146.35 m u/s & 36.59 m D/S |
| | Total length of Gallery | 1348 ft (411m) |
| | Collection point | Five manhole wells, two collection wells, and one collection well cum suction well. |
| | Conveying main | 24" dia CI pipes to D' system for District 3,4,5 with bypass connection to Arasaradi GLSR. |
| Average Discharge (Capacity) | 20.00 MLD | |
| 2 | Collector Well Head works at Kochadai | |
| | Year of construction | 1973 |
| | Distance from the town | 7.50 km. |

| S.No. | Components | Description |
|----------|---|---|
| | Diameter of Well | 4.00 m |
| | Depth of well | 17.7 m |
| | Motor HP | 135 HP (1+1) |
| | Pump Duty | Vertical Turbine, 3470 GPM (15754 lpm) @ 27.43 m Head. |
| | Length of Radial Arms | Six directions in two tiers 241 m in top tier and 348 m in the bottom tier. |
| | Conveying main | 24" CI Pipes from Kochadai to GLSR at Arasaradi. |
| | Average Discharge (Capacity) | 11.50 MLD |
| 3 | Melakkal Head works | |
| | Year of construction | 1963 |
| | Distance from the town | 18.00 km. |
| | Type | Infiltration Gallery with four manhole wells, one suction well and one collection well. |
| | Motor HP | 55 HP (1+1) |
| | Pump Duty | 3100 GPM (14074 lpm) @ 55 ft (16.77 m) Head |
| | Length of Infiltration Gallery | 304.88 m (2 rows of 18"SW pipe with cement filled joints) |
| | Length of conveying main from Melakkal to Arasaradi Pump station | 14.00 m (24" RCC) and 1,562 m (21" RCC) |
| | Average Discharge Capacity | 16.00 MLD |
| 4 | Thatchampattu Head works | |
| | Year of Construction | 1985 |
| | Distance from the town | 20 km. |
| | Infiltration wells | 3 Nos. |
| | Diameter of well | 4.50 m - 2 Nos. & 3.50 m - 1 No. |
| | Depth of well | 9 m - 2 Nos. and 10 m - 1 No. |
| | Pump Duty (Submersible) | 1,800 lpm / 13m H/ 10 HP - 2 Nos. & 1,140 lpm / 14m H/ 7.5 HP - 1 No. |
| | Motor HP | 90 HP 4741 lpm X 56 m |
| | Length of conveying main from Thatchampattu to Arasaradi Pump Station | 16.70 km; 300 mm Φ AC pipe |
| | Average Discharge (Capacity) | 4.50 MLD |
| 5 | Manaloor Head works | |
| | Year of Construction | 1987 |
| | Distance from the town | 15 km. |
| | Diameter of Collector well | 5.0 m |
| | Diameter of pump house | 6.0 m |
| | Length of Radials | 300 mm dia slotted pipes - 210 m |
| | Pump Duty at Manaloor Head works | 25 HP Turbine - 4,741 lpm / 17m Head |
| | Average Discharge (Capacity) | 4.54 MLD |
| | Length of Pumping main | 134 m. |
| | Thiruppuvanam Head works | |
| | Year of Construction | 1987 |
| | Distance from the town | 15 km. |
| | Diameter of Collector well | 5.0 m |
| | Diameter of pump house | 6.0 m |
| | Length of Radials | 300 mm dia slotted pipes - 210 m |
| | Pump Duty at Manaloor Headworks | 40 HP Turbine - 4,741 lpm / 27m Head |

| S.No. | Components | Description |
|----------|---|--|
| | Length of Pumping main From Thiruppuvanam to Manalur | 300 mm AC pipes - 3830 m. |
| | Average Discharge (Capacity) | 4.54 MLD |
| | Common Sump cum Pump house at Manalur | |
| | Capacity | 1,00,000 litres |
| | Booster Pump Duty at Manaloor | 230 HP - 9,482 lpm / 81m H |
| | Length of Pumping main From Manalur sump to Service reservoirs at New Ramnad Road and Joseph Park | 450 mm AC cl 15 - 7000 m 450 mm AC cl 10 - 5630 m |
| | Pump Duty at Thiruppuvanam Head works | 40 HP/ 4,741 lpm / 27m H |
| | Booster Pump Duty at Manaloor | 230 HP/ 9,482 lpm / 81m H |
| | Length of pumping main | 3.60 km; 350 mm Φ AC (Thiruppuvanam to Manaloor); 13.20 km.; 450 mm Φ AC (Manaloor to Joseph Park) |
| 6 | Vaigai Scheme No 1 | |
| | Year of Construction | 1995 |
| | Source | Vaigai Dam |
| | Ditance from Town | 66 km |
| | Treatment Plant Capacity | 71.6 MLD |
| | Gravity Conveying main | 1000 mm & 1100 mm PSC pipes - 66 km |
| 7 | Vaigai Scheme No 2 | |
| | Year of Construction | 2009 |
| | Source | Vaigai Dam |
| | Ditance from Town | 66 km |
| | Treatment Plant Capacity | 47 MLD |
| | Gravity Conveying main | 1000 mm & 1100 mm PSC pipes - 66 km |

Source: Madurai Corporation

42. **Status of the existing water supply schemes for core city of Madurai City Municipal Corporation:** The Madurai City Municipal Corporation supplies water to the Core city from Vaigai Dam and sub- surface water supply schemes from Vaigai River. Water Supply details are given in the **Error! Reference source not found..**

Table 9: Details of Sources and Head Works in Madurai Municipal Corporation

| S.No. | Name of Source/Scheme | Type of Source | Present Supply (MLD) | Remarks |
|-----------------|---------------------------|------------------------|----------------------|--------------------------------|
| Scheme-I | | | | |
| 1 | Kochadai | Infiltration Galleries | 8.46 | Sub-Surface Water/Ground Water |
| | Kochadai | Collector Well | | Not Functioning |
| 2 | Thachampathu Melakkal WSS | Infiltration Galleries | 14 | Sub-Surface Water/Ground Water |

| Scheme-II | | | | |
|-----------------------------------|---------------------------|---------------------------------|------------|--------------------------------|
| 3 | Manalur and Thiruppuvanam | CollectorWells | 7 | Sub-Surface Water/Ground Water |
| Vaigai Water Supply Scheme | | | | |
| 4 | Vaigai WSS, Line-I | Intake Well Vaigai Dam | 68 | Surface Water |
| 5 | Vaigai WSS, Line-II | Intake Well Vaigai Dam | 47 | Surface Water |
| Scheme-III | | | | |
| 6 | Vaigai River bed Sources | Infiltration wells | 17.54 | Sub-Surface Water/Ground Water |
| Scheme-IV | | | | |
| 7 | Melur CWSS | CollectorWells in River Cauvery | 30 | Sub-Surface Water/Ground Water |
| Total | | | 192 | -- |

Source: Madurai Corporation

43. **Total Requirement:** As per the guidelines of the CPHEEO Manual on Water Supply and Treatment, the total daily requirement of water for Madurai Municipal Corporation is as follows:

Table 10: Water Supply Demand Assessments

| S.No | Description | Water Demand | | | Remarks |
|---------------------|---------------------------------------|--------------|------------|------------|---|
| | | 2019 | 2034 | 2049 | |
| 1 | Population(in no's) | 1,628,945 | 1,923,936 | 2,277,889 | -- |
| 2 | Domestic (MLD) | 220 | 260 | 307 | 135LPCD |
| 3 | Floating Population (in no's) | 200,000 | 250,000 | 300,000 | |
| 4 | Required for Floating Population(MLD) | 9.0 | 11.5 | 13.2 | 45 LPCD |
| 5 | Fire Fighting Demand (MLD) | 4.0 | 4.5 | 4.8 | 100x√Population in 1000s in Kilo litres |
| 6 | Total Requirement(MLD) | 233 | 276 | 325 | |
| 7 | Transmission Loss @ 15% (MLD) | 35 | 41 | 49 | As per CPHEEO Norms |
| Total Demand | | 268 | 317 | 374 | -- |

29. **Existing Sustainable Supply:** The sustainable supply from all the existing water supply schemes is tabulated as below:

Table 11: Existing Sustainable Supply

| S. No. | Source | Quantity Available |
|--------------------------|---|--------------------|
| Perennial Source: | | |
| 1. | First Vaigai Water Supply Scheme | 68.00 MLD |
| 2. | Second Vaigai Water Supply Scheme | 47.00 MLD |
| 3. | Cauvery CWSS (allotment upto ultimate period) | 30.00 MLD |

| S. No. | Source | Quantity Available |
|--|--------------------------|--------------------|
| | Sub Total (A) | 145.00 MLD |
| Non Perennial Source (Vaigai River bed source): | | |
| 4. | Melakkal & Thachampathu | 14.00 MLD |
| 5. | Manaloor & Thiruppuvanam | 7.00 MLD |
| 6. | Kochadai | 8.46 MLD |
| 7. | Avaniyapuram | 17.54 MLD |
| 8. | Thiruparankundram | |
| 9. | Thirunagar | |
| 10. | Harveypatti | |
| 11. | Anaiyur | |
| 12. | Vilangudi | |
| | Sub Total (B) | 47 MLD |
| | Grand Total (A+B) | 192 MLD |

44. **Net Water Supply Requirement for Intermediate Stage 2034:** The net water supply demand for the intermediate year 2034 calculated from the above tables is as follows:

- Total water supply demand for 2034 : 317 MLD
- Existing Water Supply : 192 MLD
- Water supply Demand Gap for 2034 : 125 MLD

45. The water supply Demand Gap for 2034, the intermediate requirements shall be fulfilled by this proposed 125 MLD dedicated water supply scheme for Madurai Municipal Corporation from Mullaiperiyar River as source of water.

Table 12: Water Supply Demand Gap Statement for the Existing and New Water Supply Distribution Zones

| S.No. | Proposed Water Supply Zones | Demand in MLD | | |
|-------|-----------------------------|---------------|------|------|
| | | 2019 | 2034 | 2049 |
| 1 | Total Demand | 268 | 317 | 374 |
| 2 | Existing Water Supply | 192 | 192 | 192 |
| 3 | Proposed Water Supply | 125 | 125 | 125 |
| 4 | Total Supply (2) + (3) | 317 | 317 | 317 |
| 5 | Demand Gap (1) - (4) | Nil | Nil | 57 |

Source: Madurai Corporation

46. **Scheme-I:** This scheme contributes a partial yield through existing collector well/ Infiltration galleries installed on Vaigai River bed at Kochadai, Melakkal and Thatchampattu. Through this scheme, water is supplied to the North Zone of the city from September to February. Though the design capacity of the Head Works is about 52MLD, presently about 29.46 MLD of water is available from riverbed.

47. **Scheme-II:** In this scheme, the head works are located at Manalur and Thiruppuvanam on Vaigai River bed. Through this scheme, water is supplied to South Zone, through the existing collector well/infiltration well during monsoon season. The design capacity of the scheme is about 9.08 MLD but presently only 7.0 MLD of water is extracted from, the head

works. Both the Collector wells are in the Downstream of Madurai Municipal Corporation. Due to the pollution in River Vaigai, the quality of water from the above Collector wells are deteriorated and the TDS is in the range of 1300 mg/l. Bacteriological pollution was also observed during lean flow season no flow in the River for dilution. Hence, the Collector wells are not functioning for the past four years. A Water Treatment Plant (WTP) of capacity 5 MLD was constructed near the Manalur Collector well to treat the water with aerator and Filter beds having anthracite coal as filter media. Further, the conveying main of 450 mm AC pipes from Manalur to the New Ramnad Road were damaged in many places during road widening. Hence, the above pipes are now replaced with 450 mm DI K7 pipes by Madurai Municipal Corporation

C. Proposed Project

48. It is proposed to draw 125 MLD (1630 MCFT/year) of surface water from the proposed Check Dam in Mullai Periyar River at Lower Camp to fulfill the intermediate demand gap of 125 MLD for Madurai Municipal Corporation.

49. Madurai Municipal Corporation drinking water need is being managed with the allotted quantity of 1500mcft (115 MLD) at Vaigai Dam, 30 MLD from River Cauvery Source under Melur CWSS and 47 MLD from Vaigai River Bed. The Intermediate water supply demand for 2034 (with projected population of 19,23,936) is 317 MLD. From all existing sources the designed quantity of water available is 192 MLD. The water supply demand gap for 2034 is estimated to be 125 MLD. To meet the demand gap of 125 MLD the Madurai City Municipal Corporation has analysed the possibilities of drawal of water from Mullai Periyar River at Lower camp through closed conduits.

- In G.O.No.872, Public Works Department Dated. 04.06.1985 Government has allotted 1500 MCFT from Vaigai Dam, through this 115 MLD of water is being drawn every day. There is a huge gap between available quantity and demand.
- Vaigai Dam receives water from Mullai Periyar Dam. During summer 200 cusecs of water is being released for Water Supply Demand of Theni & Madurai Districts. The head works in the upstream side of Vaigai Dam are tapping 100 cusecs of water for the local bodies in the Theni District but due to evaporation and percolation of loss the remaining 100 cusecs is not reaching Vaigai Dam, only 40 cusecs are reaching Vaigai Dam.
- Hence, to avoid evaporation percolation losses, it is now proposed to draw 125 MLD of raw water from Mullai Periyar River at Lower Camp through closed conduits.

50. **Subproject Components:** The DPR is prepared for the construction of key subproject components including the Check Dam, Intake arrangements and Laying of 1118 mm and 1067mm MS Raw Water pumping main to the proposed Water Treatment Plant at Pannaipatti. The detailed description of the subproject components are as follows

(i) Head Works:

51. The Headwork's site is proposed in the right riverbank of Mullai Periyar River, near the downstream of 18th Canal Check Dam.

The main components in the Head Works are.

- | | |
|---|---------|
| 1. Construction of Check Dam | |
| 2. Construction of 3m dia Semicircular Intake Wells | : 4 Nos |
| 3. Construction of Collection Wells | : 1 No |
| 4. 700mm MS Connecting Pipe | : 4 Nos |

5. Construction of Protection Wall for Head Works site : 1 No



Figure 3: Satellite imagery of Mullai Periyar Dam



Snap shot 1: Proposed head work site and check dam location

(ii) Check Dam:

52. It is proposed to draw 125 MLD raw water from Mullai Periyar River at Lower Camp by the construction of Check Dam across the River in the downstream of 18th Canal Check Dam. The MSL of the riverbed at 18th Canal Check Dam and the proposed Check Dams are 477.40 m and 474.00m respectively. Due to this steep gradient of river course, the depth of

flow shall be 2.0 m for maximum flow of 2100 cusecs and 45 cm for minimum flow of 200 cusecs.

53. During the peak summer, the minimum quantity of 200 cusecs is released to meet the drinking water requirement of Madurai and Theni Districts. In this proposal 4 numbers of 700 mm dia MS connecting pipes are proposed to draw 130 MLD(4 x 32.50 MLD) of raw water from the River. So the minimum 1.5 m depth of water head is required in the river where the 125 MLD of water has to be drawn. During the peak summer, the above said minimum depth of flow shall not be available. Hence, it is essential to head up the water level at the intake well. By considering the above observations, now it is proposed to construct a Check Dam to head up the water level of 2.50 m for the all-time successful drawal of 125 MLD of Raw Water required for Madurai Corporation. The Check Dam is proposed across the River Mullai Periyar at 350 m downstream of 18th canal Check Dam.

Salient Details of Check Dam:

| | | |
|---------------------------------------|---|---------|
| Length of Check Dam | : | 60 m |
| River Bed Level | : | 474.00m |
| Invert Level of 700 mm MS intake pipe | : | 474.30m |
| Crest level of Check Dam | : | 476.50m |

54. The provision towards the construction of Check Dam is made in the estimate which will be executed by PWD Authorities as Full Deposit work.



Snap Shot 2: Existing check dam for Cumbum valley water supply project

(iii) Intake Arrangements:

a) 3m dia Semicircular Intake wells - 4no's

55. It is proposed to construct 4no's of 3m dia semicircular intake wells along the protection wall proposed in the riverbank side at 3m interval. These intake wells are provided

with suitable screening arrangements. Through the each intake wells, 32.50MLD of water shall be drawn from the proposed check dam.

b) Construction of collection wells

56. It is proposed to construct a collection well with silt trap at Head Works to collect 125 MLD of water from 4no's of intake wells through 4 rows of 700mm MS connecting pipes.

c) Protection wall

57. The existing ground level of the Head Works site is 476.50 m. The actual ground level of the existing Head Works of Cumbum Valley Water Supply Project is 478.50 m. Hence, it is necessary to raise up the existing ground level up to 478.50 m. Therefore, a protection wall is proposed all around the Head Works site to raise the Ground level up to 478.50 m by filling with imported earth. The proposed protection wall at Head Works site is 185 m X 55 m.

Salient details of proposed head works at lower camp

Check Dam

| | | |
|-----------------|---|--------|
| Average G L | : | 478.50 |
| River Bed Level | : | 474.00 |
| Crest Level | : | 476.50 |

Head Works Site

| | | |
|----------------------|---|---------|
| Existing Average G L | : | 476.500 |
| Proposed G L | : | 478.500 |

Semi Circular Intake

| | | |
|------------------------|---|--------------|
| Wells – 3 m Dia | : | 4 Nos |
| Average G L | : | 478.500 |
| Bed Level | : | 474.300 |
| MFL | : | 478.000 |

| | | |
|-------------------------|---|-------------|
| Collection Wells | : | 1 No |
| Average G L | : | 478.500 |
| LWL | : | 473.500 |
| MFL | : | 478.000 |

| | | |
|------------------------|---|--------------|
| Connecting main | : | 4 Nos |
| 700 mm Dia MS pipes | : | 4 x 30 m |

Protection Wall around

| | | |
|------------------------|---|---------------------|
| Head works site | : | 185 m x 55 m |
|------------------------|---|---------------------|

58. **Raw water pumpset:** The pumpsets are designed for the requirements at an intermediate stage (year 2034). It is proposed to install six vertical turbine pump sets (each 280 HP), each with a capacity of 23555 lpm against a head of 40 m, four would be working and two would be standby with a total pumping capacity of 94210 lpm to meet the intermediate stage demand. The design is based on 23 hours pumping rate.

59. **Raw water pumping main:** As sufficient land is not available near the head works location for the construction of Water Treatment Plant (WTP), it is proposed to pump the raw water to Pannaipatti, where the new WTP (125 MLD capacity) is proposed. The raw water pumping main is proposed for a length of about 95740m for conveying raw water from intake well, located at the bank of the River Mullai Periyar, to the proposed water treatment plant to deliver 125 MLD of raw water to meet the estimated demand for the Year 2034. The materials for pipelines will be selected as per the guidelines and pipe policy issued by TWAD Board or GoTN pipe policy. The pipeline is designed to meet the ultimate demand.

60. The proposed Raw Water Pumping Main has to cross the bridges as shown in the Table 13 and accordingly suitable pipe carrying bridges are proposed. The status of approval is enclosed in **Appendix 10**.

Table 13: Proposed Pipe carrying bridges

| S. No. | Location | MS Pipe size | Length in 'm' |
|---|--------------------------------------|--------------|---------------|
| I. HeadWorks - Sengkulam stand post | | | |
| 1. | Kovanoothu bridge at LS: 2355m | 1422mm | 110m |
| 2. | Uthamapalayam at LS: 25400m | 1219mm | 100m |
| II. Sengkulam stand post - Pannaipatti WTP | | | |
| 1. | Aranmanai Pudur at LS: 22100m | 1219mm | 100m |
| 2. | Kunnoor at LS :23590m | 1219mm | 150m |
| 3. | Vaigai Dam Pickup Weir at LS: 37410m | 1219mm | 200m |
| 4. | Varaganathi at LS: 45270m | 1219mm | 140m |
| 5. | Punnukuthi Odai at LS: 47850m | 1219mm | 140m |

Source:Madurai Municipal Corporation

61. Further, there are two railway crossing come across the Raw Water Pumping Main at Theni - Aranmanai Pudur road junction. Necessary provision has been provided in the estimate for this railway crossing.

Table 14: Details of Railway Crossings

| Description | Location | Chainage | Length In M |
|-------------------|---------------------------------|----------|-------------|
| Railway Crossings | Near Karuppatti Railway Station | 30500 m | 60 |
| | Near Thachampatthu | 36500 m | 60 |

Source: Madurai Municipal Corporation

(iv) 125 MLD Full Scale Water Treatment Plant (WTP): The proposed Water Treatment Plant will be constructed in 5 acre land proposed near the existing WTP at Pannaipatti Village, Nilakottai taluk, Dindigul District. The treatment plant layout has to be planned to treat 125 MLD of raw water (Ultimate stage requirement). The land proposed for WTP is Corporation own land. The proposed WTP will be based on conventional treatment process with full scale treatment involving coagulation, flocculation, sedimentation, filtration process, disinfection etc. The Construction of WTP is proposed under Design and Build basis as per the process specified to suit the available site. Since the raw water is not suitable for the drinking purpose, the water treatment plant is proposed to treat raw water to meet the drinking water standards and supplied to consumers.

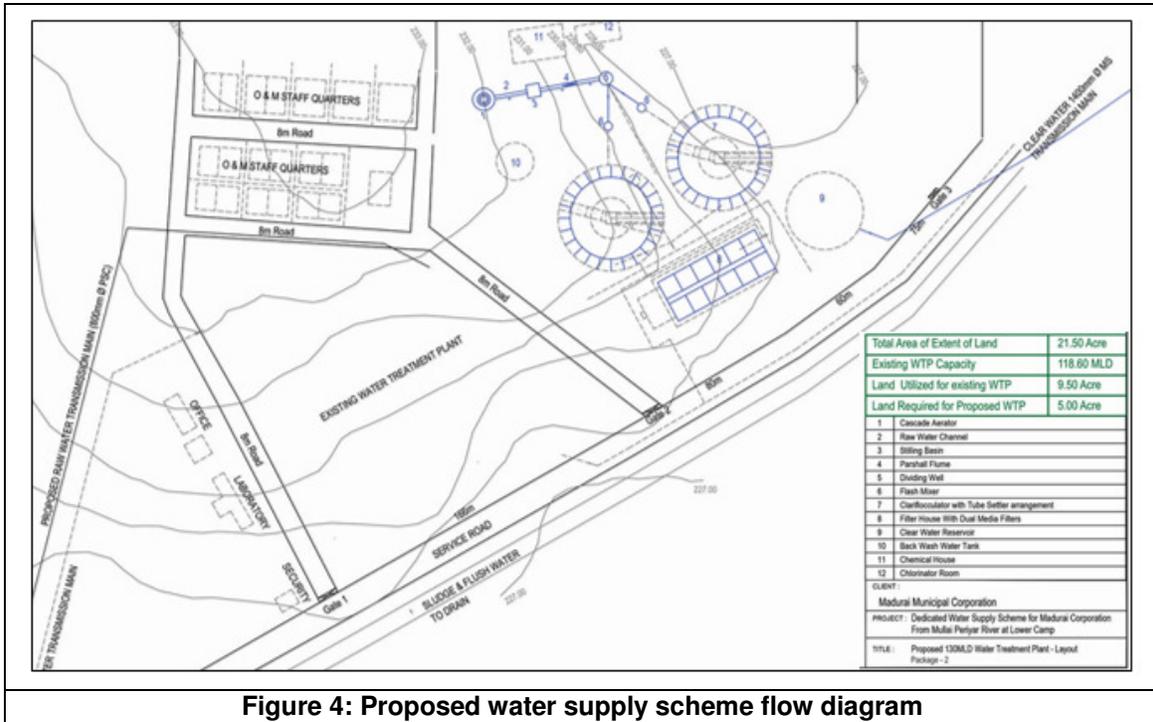


Figure 4: Proposed water supply scheme flow diagram

a) Design Process

62. The design of the Water Treatment Plant shall be in compliance with the requirements of CPHEEO Manual of Water supply and Treatment, Third Edition 1999 published by the expert committee of Central Public Health & Environmental Engineering Organisation, Govt. of India and relevant BIS codes of practice. The source of water is from Mullai Periyar River at Lower camp through closed conduits.

63. The Water Treatment Plant (WTP) will be constructed through DBOT basis; it shall be designed for continuous operation to produce net output of 125.00 MLD in 24 hrs. (Considering raw water intake available is 125 MLD with 4 % losses in Water Treatment Plant) operation of treated water to specified quality standard. The treatment plant scheme shall broadly comprise of Cascade Aerator, Parshall Flume, Flash mixer, Clariflocculator, Rapid gravity filters and Chlorine mixing tank for delivering treated water of specified physical, chemical, and bacteriological quality. The sludge from Clariflocculators shall be taken to the sludge balance tank and from there to discharge to drain nearby. Dirty Backwash from the filters is routed to the used backwash recovery tank from which the supernatant is recycled back to the inlet chamber of WTP and the sludge generated is stored and disposed to ULB approved disposal/ processing facility. The design basis considered for the water treatment plant is as given below.

b) Design Capacity of the plant

- Net output capacity: 125MLD over 24 hours operation (4.0% losses in WTP)
- All Channels / Pipes / Valves / Weirs: Designed for 20% overloading conditions.

c) Treatment Philosophy

64. The water treatment plant is designed for a treated water output of 125 MLD in 24 hours. The Hydraulics of the treatment plant is designed in such a way that water flows by

gravity from the cascade aerator to the existing clear water reservoir and the sludge generated from the clariflocculators flows by gravity to the sludge balance tank.

- Broadly, the flow scheme comprises the following process units:
 - Stand post of Capacity 10LL With 12M Staging:1No
 - Cascade Aerator: -1 No.
 - Parshall Flume: -1 No.
 - Flash Mixers: -2 Nos.
 - Clariflocculators: -2 Nos.
 - Rapid Gravity Sand Filter House: -1 No.
 - Chlorine Mixing Tank: -1 No.
 - Sludge Balancing Tank:- 1 No. with 2 compartments
 - Used Backwash Recovery Tank :- 1 No. with 2 compartments
 - Clear Water Sump:-1 No.

d) ProcessDescription

65. **Stand post** (OfCapacity10 LL): The available residual head in Raw Water Transmission Main at Pannaipatti WTP site is 19.47 m. As per CPHEEO Manual on water supply and Treatment,the head requirements over the tip of the aerator should be 0.5m to 3.0 m. To maintain the required residual head over the Aerator, a stand post of 10 LL capacity with 12 m staging height is proposed at WTP site to receive the 125 MLD of Raw water from the raw gravity transmission main.

66. **Cascade Aerator cum Inlet Chamber:**The raw water is cascade aerator to release of odour and then received in the Inlet chamber of 1 minute's detention time for a design flow for 125.00 MLD at 24 hrs operations to achieve quiescent conditions.

67. **Parshall Flume/Inlet Flume:**The water from Inlet chamber then flows through channel installed with Parshall flume of standard design where flow measurement instrument is installed to monitor and record flow through the channel. Pre-chlorination is done by means of chlorine solution through diffusers installed to control organics.

68. **Flash Mixer:** Two Nos. flash mixers each designed to achieve an intimate mixing of raw water with alum dosed into the raw water. Each flash mixer is constructed in RCC with 60 seconds retention time and provided with agitator.

69. **Clariflocculator:** The overflow from the flash mixer shall enter the pipe leading to flocculation of the clariflocculator for further flocculation & settling. Two numbers of clariflocculators, constructed in RCC is provided with flocculators clarifier raking mechanism. The clarifiers are provided for removal of Turbidity, Suspended matter, Organic, etc. The coagulated water enters the reaction zone through a pipe to undergo reaction with the re-circulated sludge and chemicals. The flocculated water enters the clarifier zone to undergo the sedimentation process and the clarified water flows through launders plates and enters into a common clarified water channel, which leads to the filter inlet channel. The sludge collected at the bottom is scrapped slowly to the central sludge pocket by means of sludge scrapping mechanism from where it is withdrawn and led to sludge balancing tank.

70. **Rapid Gravity Sand Filters:** The clarified water from the clariflocculator clarifier enters into the common filter feed channel and routed to 6no's rapid gravity filters, each filter designed for a filtration rate of $6 \text{ m}^3/\text{m}^2/\text{hr}$. The filters shall be of the duplex type comprising

two equal size beds separated by a central used wash water collection channel and operating at constant rate on the principle of influent flow division and constant water level.

71. The filters shall be arranged in two banks located on either side of a covered central gallery containing a walkway and fresh water consoles at high level and filter pipe gallery and filtered water channel complete with walkway at low level. The pipe gallery shall house the filter outlet chamber, common clear water channel and backwash water piping from the tank and air scour piping with valves. The gallery in the filter house is provided with adequate lighting and ventilation. The flow from the filter inlet channel enters each filter and undergoes filtration through sand media.

72. The filtered water is collected through the under drain system comprising nozzles set in a plenum concrete floor and flows into an outlet chamber fitted with weir plate and overflows into the common filter water channel. When the filter head loss increases due to clogging of the bed, the filters shall be taken for backwashing using air and water.

73. **Back Wash Tank:** When the filter head loss increases due to clogging of the bed, the filters shall be taken on back washing using air and water. There shall be a backwash storage tank (rectangular tank on top of filter gallery) which will deliver the backwash water. The backwash storage tank shall be filled by pumps, which will take the water from the sump in the filtered water channel.

74. **Filter Annex Building:** Dedicated air scour blowers and backwash water pumps of adequate capacity to backwash one complete filter bed are provided. The backwash from the filters is routed by gravity to used wash water recovery tank from where the settled backwash sludge is stored and disposed to ULB approved disposal/ processing facility..

75. **Chlorine Mixing Tank:** The filtered water passes through a Chlorine contact tank where post chlorination is done. Chamber is of RCC construction with baffles and covered.

76. **Treated Water Reservoir:** After filtration, the filtered water from filter house is taken to the existing Treated water reservoir.

77. **Sludge System:** The sludge generated from the clariflocculators is routed to the sludge-balancing tank from where the sludge is stored and disposed to ULB approved disposal/ processing.

78. **Chemical Dosing System:** The following chemical dosing systems of adequate capacity dosing tanks with agitators and dosing pumps:

- **Alum solution preparation & dosing system:** Alum is used as a coagulant in the removal of raw water turbidity.
- **Hydrated Lime solution preparation & dosing system:** Lime is used to maintain the alkalinity of water. The dosage of lime is decided depending upon the dosage of alum and alkalinity of raw water.
- **Pre & Post chlorination system:** Chlorinators for pre-chlorination and for post chlorination with all standard accessories as required to make the system complete.

79. A chemical storage house of RCC framed structure construction with brick walls, with rooms having proper corridor approach, with proper natural lighting & ventilation is provided. There shall be access, to first floor and roof by means of stairs with filtered water connection in each floor for floor washing and for water required for preparing chemical solutions. The Liquid chlorine cylinder (18-20 nos) will be stored in the room and other chemicals like Alum & Lime (15 - 20 T) will be stored for treatment system.

80. **Safety / Precaution:** When working with chlorine Wear glasses, masks, gloves, rubber boots, PVC aprons, use hood mask, airline mask and breathing apparatus. In case of chlorine leakage, The following instructions will be followed:

- If the leakage cannot be stopped, inform to the supplier. If not able to find the supplier, call the closest producers.
- A capable, implemented staff having enough equipment must interfere the leakage. Move the other staff over a high place by taking the wind at backside. If the leakage is so thick, take all the staff away.
- To find out the leakage pour ammonia in to the suspicious area. A white smoke exists if there is a leakage. Control all the equipments at least once a day.
- If the leakage is in the equipment or in pipes, close the chlorine input valve and transfer the pressured chlorine to an absorption system.
- If possible, decrease the pressure in container by transferring the gas to process or drainage system. Use an emergency bag. Inform to supplier. If not able to find the supplier, call the closest producer and ask for help. It is forbidden to transfer chlorine with leaking containers.
- Do not use water in chlorine leakages. Never put the chlorine cylinder or container to water or a liquid chemical mass. Prepare an absorption solution containing caustic soda and soda ash in a tank. For emergency reasons, keep these chemicals available for preparation of solution. Never put the leaked chlorine cylinder or container to absorption tank.

81. **Storage:** Chlorine cylinders, full or empty; should be stored in a dry and cool place and kept away from all kinds of sources of heat. Do not store beside elevators or ventilation systems. The places underground should not be preferred for storage.

- The storage temperature must not be over 55°C. These cylinders must be stored away from other compressed gas containers. Do not store near turpentine, ether, hydrocarbons, other flammable substances, ammonia and metal granules. Despite of oxidation risk, keep the warehouse clean.
- Should be stored where the daily controls and transportation of the full containers can be done with the least effort.
- Keep the full and empty containers in different places. Keep small cylinders vertical and bigger ones horizontally.

82. **Hydraulics:** Top water Level of Existing Treated Water Reservoir is considered as 229.5 m, accordingly hydraulics shall be designed.

83. **Clear Water Gravity Transmission Main** The treated water from the clear water reservoir will be conveyed by gravity to the proposed 56 OHTs (52 from Mullai periyar and 4 from Cauvery CWSS) within the Madurai Municipal Corporation area. The total length of gravity clear water main and feeder mains from the WTP to the OHTs is around 54.5 Km with a diameter of 1400 mm. The clear water main is proposed to be laid along the PWD channel, SH, Rural Road and Vaigai River Bank upto the city limit. After crossing NH 7, the alignment will be in line with the state Highways and local roads.

Table 15: Details of Clear Water Transmission Main

| Chainage of Clear Water Main from Collection Sump (m) | Length (km) | Diameter (mm) | Pipe Thick (mm) | Pipe Material |
|---|-------------|---------------|-----------------|---------------|
| LS 0 to 54435 | 54.435 | 1422 | 12.50 | MS |

e) Feeder Mains

84. MS Feeder Main: The 125 MLD of water received from the clear water transmission main is distributed to the Service Reservoirs through feeder mains of sizes varies from 100mm Φ to 900mm Φ DI pipes and MS pipes.

In this proposal, MS pipe feeder mains are accounted as given below.

914 mm x 8 mm thick MS Pipe : 6,845 m

711mm x 6.3 mm thick MS Pipe : 3,645 m

85. **DI FeederMain:** The Madurai Municipal Corporation has prepared two DPRs for water supply distribution system, one for added area and another one for Madurai Core City, which is under government approval. In these two DPRs there are 100 no's of water supply distribution zones have been proposed for equitable distribution of water. In this 100 water supply distribution zones, 44 zones are proposed with existing service reservoirs and 56 zones are with newly proposed service reservoirs (covered under this proposal). In this project, it is proposed that 50 zones are covered by 125MLD of water from Mullai Periyar River to feed 52 no's. of newly proposed service reservoirs and 3 zones covered by 8.97 MLD of water supply from Melur CWSS to feed 4 Nos. of newly proposed service reservoirs and also 3.50 LL/day water is supplied to The Chennai High Court Branch, Madurai from 8.97 MLD water supply from Melur CWSS.

86. For the 914 mm x 8 mm thick MS feeder main Vaigai River Crossing at LS 54435m, pipe protection barrier wall has been provided across the Vaigai River for a length of 280m.

87. **Storage reservoirs:** The entire Madurai City Municipal Corporation area is presently divided into hundred water distribution zones based on the elevation of the city. These zones will have OHT, which will directly receive water from Existing & Proposed Water Supply Scheme. Totally 100 OHT are required as storage reservoirs (existing OHT's = 44 nos., proposed OHT's = 56 nos.). Out of 56 OHT's, 52 OHT's are being constructed under the AMRUT scheme by Madurai Municipal Corporation and balance 4 OHT's are being constructed under the Cauvery CWSS.

88. **Distribution Network: Distribution system for 14 distribution zones of Madurai Corporation is proposed to be provided in this project.**

89.

Status of the water supply distribution system in Madurai Municipal Corporation: Madurai Municipal Corporation encompasses 4 administrative zones consisting of 100 wards and 100 water distribution zones. Madurai Corporation proposes to provide distribution system to all the zones including added areas. Distribution system for 9 distribution zones are being implemented under Smart City funding. Of the remaining, 14 distribution zones will be covered under the proposed Madurai WSIS under TNUFIP and for the balance 77 Distribution zones, DPR is under finalization and will be taken up by Madurai Corporation subsequently.

D. Implementation Schedule

90. The Bids for water supply schemes will be invited in December 2018 and the contract will be awarded by April 2019. Construction is likely to start in April 2019 and will take about 24 months to complete.

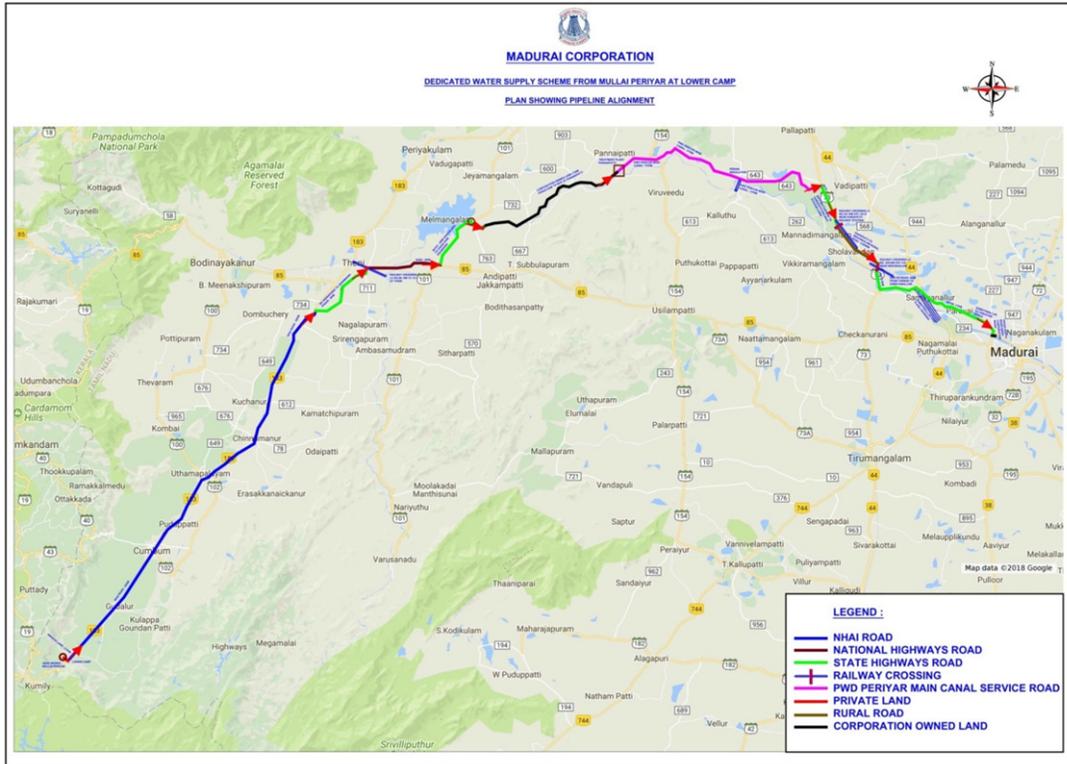


Figure 6: Map showing Pipeline drawing for water supply to Madurai Corporation

III. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. ADB Policy

91. ADB requires the consideration of environmental issues in all aspects of ADB's operations, and the requirements for environmental assessment are described in ADB SPS, 2009. This states that ADB requires environmental assessment of all ADB investments.

92. **Screening and categorization.** The nature of the environmental assessment required for a project depends on the significance of its environmental impacts, which 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 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 Category 'A' projects. An Initial Environmental Examination 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 bank funds to or through a Financial Intermediary (FI).

93. **Environmental Management Plan:** An EMP, which addresses the potential impacts and risks identified by the environmental assessment, shall be prepared. 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.

94. **Public disclosure:** ADB will post the safeguard documents on its website as well as disclose relevant information in accessible manner in local communities:

- (i) for environmental category A projects, draft EIA report at least 120 days before Board consideration;
- (ii) final or updated IEE upon receipt; and
- (iii) environmental monitoring reports submitted by the implementing agency during project implementation upon receipt.

B. National Environmental Laws

95. **Environmental assessment:** The GoI EIA Notification of 2006 (replacing the EIA Notification of 1994), set out the requirements 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.

96. **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.

97. **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 10 km from the boundary of protected areas, notified areas or inter-state or international boundaries.

98. None of the components of this water supply scheme subproject falls under the ambit of the EIA Notification 2006, and, therefore EIA Study or EC is not required for the subproject.

99. **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 16**.

Table 16: Applicable Environmental Regulations

| Law | Description | Requirement |
|--|---|---|
| Water (Prevention and Control of Pollution) Act of 1974, Rules of 1975, and amendments | An Act 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 to this Act. All pollution potential activities will require Consent to Establish (CTE) from Tamil Nadu Pollution Control Board (TNPCB) before starting implementation and Consent to Operate (CTO) before commissioning. | Construction of proposed WTP (125 MLD) requires CTE and CTO from TNPCB before starting construction and before commissioning of WTP respectively. Application has to be submitted online at http://tnocmms.nic.in/OCMMS/ |
| 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 |
| Noise Pollution (Regulation and | Rule 3 of the Act specifies ambient air quality standards in respect of noise for | To comply with the noise standards. |

| Law | Description | Requirement |
|---|--|--|
| Control) Rules, 2000 amended up to 2010. | different areas/zones. | |
| Air (Prevention and Control of Pollution) Act, 1981, amended 1987 and it's Rules, 1982. | <p>Applicable for equipment and machinery's potential to emit air pollution (including but not limited to diesel generators and vehicles);</p> <ul style="list-style-type: none"> • CTE and CTO from TNPCB; • Compliance to conditions and emissions standards stipulated in the CTE and CTO. | Generators will require CTE and CTO from TNPCB and has to comply with applicable emission standards as well |
| Solid Wastes Management Rules, 2016 | Rules to manage municipal solid waste generated; provides rules for segregation, storage, collection, processing and disposal. | Solid waste generated at proposed facilities shall be managed and disposed in accordance with the SWM Rules |
| Construction and Demolition Waste Management Rules, 2016 | Rules to manage construction and to waste resulting from construction, remodeling, repair and demolition of any civil structure. Rules define C and D waste as waste comprising of building materials, debris resulting from construction, re-modeling, repair and demolition of any civil structure. | Construction and demolition waste generated from the project construction shall be managed and disposed as per the rules |
| 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 equal opportunity and fair treatment, and shall not discriminate with respect to aspects of the employment relationship, 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. | Appendix-2 provides applicable labor laws including amendments issued from time to time applicable to establishments engaged in construction of civil works, , which will need to be followed by the project. |
| Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 (MSIHC Rules, 1989) | Never expose cylinders to heat, Always keep the valve protection cap in place, except when the cylinder is being used, never lift a cylinder by its valve protection cap, Cylinders must be kept upright at all times when moved or stored. Secure chlorine containers with chains, chocks or appropriate equipment. | To comply with the storage and import of hazardous chemicals rules. |

100. **Clearances / permissions to be obtain by Contractor.** Following Table shows the list of clearances/permissions required for project construction. This list indicative and the contractor should ascertain the requirements prior to start of the construction, and obtain all necessary clearances/permission prior to start of construction.

Table 17: Clearances and permissions required for Construction

| S. No | Construction Activity | Statutory Authority | Statute under which Clearances Required | Implementation | Supervision |
|-------|--|---|---|------------------|-------------|
| 1 | Tree Cutting | Department of Forest and District Collector/DRO | Clearances from the authorities as per the Tamil Nadu Timber Transit Rules, 1968 or latest. | PIU | PIA and PMU |
| 2. | Construction of WTP | TNPCB | Consent to establish and consent to operate under Water Act, 1974 and Air act 1981 | Contractor & PIU | PIU |
| 3 | Hot mix plants, Crushers and Batching plants | TNPCB | Consent to establish and consent to operate under Air Act, 1981 | Contractor | PIU |
| 4 | Discharges from construction activities | TNPCB | Consent to establish and consent to operate under Water Act, 1974 | Contractor | PIU |
| 5 | Storage, handling and transport of hazardous materials | TNPCB | Hazardous Wastes (Management and Handling) Rules, 1989 Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989 | Contractor | PIU |
| 6 | 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 | PIU |
| 7 | New quarries and borrow areas | MOEF&CC | Environmental clearance under EIA Notification 2006 | Contractor | PIU |
| 8 | Groundwater extraction | Public Works Department | (Groundwater) Tamil Nadu Groundwater Development and Management Act 2000 | Contractor | PIU |
| 9 | Disposal of bituminous wastes | Tamil Nadu State Pollution Control Board | Hazardous Wastes (Management and Handling) Rules. 1989 | Contractor | PIU |
| 7 | Temporary traffic diversion measures | - | MoRTH 112 SP 55 of IRC codes | Contractor | PIU |
| 8 | Water source (With drawl) | PWD | Permission obtained attached as Appendix 9 | PIU | PIU |
| 9 | Pipe carrying bridge | PWD | Permission Obtained | PIU | PIU |

101. **ADB SPS Requirements:** During the design, construction, and operation of the project the PMU and PIUs 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 regulations differ from these levels and measures, the PMU and PIU in Madurai Corporation will achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, the PMU and PIU Madurai Corporation will provide full and detailed justification for any proposed alternatives that are consistent with the requirements presented in ADB SPS.

Table 18: WHO Ambient Air and WHO Noise Level Guidelines

| WHO Ambient Air Quality Guidelines ^{7, 8} | | | Noise Level Guidelines ⁵⁴ | | |
|--|----------------------|---|--------------------------------------|--------------------------|----------------------------|
| | Averaging Period | Guideline value in $\mu\text{g}/\text{m}^3$ | One Hour L_{Aeq} (dBA) | | |
| | | | Receptor | Daytime 07:00 - 22:00 | Nighttime 22:00 - 07:00 |
| Sulfur dioxide (SO ₂) | 24-hour | 125 (Interim target-1) 50 (Interim target-2) 20 (guideline) | | 55 | 45 |
| | 10 minute | 500 (guideline) | | | |
| Nitrogen dioxide (NO ₂) | 1-year 1-hour | 40 (guideline) 200 (guideline) | | | |
| Particulate Matter PM ₁₀ | 1-year | 70 (Interim target-1) 50 (Interim target-2) 30 (Interim target-3) 20 (guideline) | | | |
| | 24-hour | 150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (guideline) | | | |
| Particulate Matter PM _{2.5} | 1-year | 35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (guideline) | | | |
| | 24-hour | 75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) 25 (guideline) | | | |
| Ozone | 8-hour daily maximum | 160 (Interim target-1) 100 (guideline) | | | |
| | | | Industrial; commercial | 70 | 70 |

IV.

IV. DESCRIPTION OF THE ENVIRONMENT

A. Methodology used for Baseline Study

102. **Data collection and stakeholder consultations.** Data for this study has been primarily collected through comprehensive literature survey, discussion with stakeholder agencies and field visits to the proposed subproject sites.

103. The literature survey broadly covered the following:

- (i) Project details, reports, maps, and other documents prepared by Madurai Municipal Corporation.
- (ii) Discussions with technical experts, publics and other relevant government agency.
- (iii) Secondary data from previous project reports and published articles, and
- (iv) Literature on land use, soil, geology, hydrology, climate, socioeconomic profiles, and other planning documents collected from Government agencies and websites.

104. In order to predict the anticipated impacts due to an infrastructure project implementation/ construction, it is necessary to obtain baseline information of the environment, as it exists, which would serve as a datum. The interaction of baseline environment and the anticipated impacts are the basis for the preparation of the Environmental Management Plan. This chapter includes existing scenario for various environmental components of the study area. The baseline environmental quality status is assessed through field studies in the study area for various components of environment, viz, air, noise, water, land, biological and socio-economic. Baseline data collection for each of the environmental components is based on the location of proposed project and anticipated distance of the significant impact. The study area is defined for each of the environmental components independently taking into consideration the vulnerability of the environmental component with respect to the activity of the proposed project. Majority of data on water quality, vegetation, air and noise quality was collected during field studies.

105. **Ocular inspection:** Several visits to the project sites were made during IEE preparation period in 2018 to assess the existing environment (physical, biological, and socio-economic) and gather information with regard to the proposed sites and scale of the proposed project. A separate socioeconomic study was conducted to determine the demographic information, existing service levels, stakeholder needs and priorities.

B. Physical Environmental Component

106. Considering the environmental setting of the project, project activities and their interaction, environmental regulations and standards, the following Environmental attributes have been included for the IEE. The study was conducted at 8 locations in project alignment area.

- Site-specific micrometeorological data for the parameters of Windspeed & direction, Temperature, Humidity, Cloud Cover and Rainfall.
- Ambient Air Quality at 8 locations for the parameters: PM₁₀, PM_{2.5}, SO₂, NO₂.

- Noise Level Measurements at 8 Locations for both Leq-Day and Leq-Night values.
- Water Quality:Surface Water at 2 Locations and Groundwater at 6 Locations for IS: 10500 Norms.
- Soil Quality at 8 Locations for Textural & Physical Parameters, Nutrients, etc.
- Present & Post-project Land Use Pattern based on Satellite Imagery.
- Biotic Attributes: Flora & Fauna -Core zone & Buffer zone-Diversity Index.
- Socio-Economic Profile (2011 Census): Total Population, Household Size, Age, Gender Composition, SC/ST, Literacy Level, Occupational Structure, etc.

a. Micrometeorology

107. As a part of the study, the micrometeorology and microclimatic parameters were recorded by using a weather monitoring station. Information related to wind velocity; wind direction, ambient temperature and relative humidity were recorded. From the observation, the maximum temperature of 36.5°C was recorded for the month of April 2017 and minimum temperature of 25.7°C was recorded for the month of June 2017. The predominant wind direction was towards South West Direction during the study period. Using the data, suitable wind rose diagram are also prepared and depicted in the Figures 6, 7 and 8 respectively. The maximum wind velocity was observed 13 m/s during the period of June 2017, and the minimum wind velocity was observed 1 m/s during the period of April and May 2017. Relative Humidity ranges from 60 % to 96 %. The maximum humidity was observed during the month of June 2017 and the minimum humidity was observed in April 2017. The outcome of the monitoring is given in the Table 20, 21 and 22 respectively.

Table 19: Meteorological data for the month of April 2017

| Date | Temperature (°C) | Wind Direction | Wind Velocity (m/s) | Relative Humidity |
|------------|------------------|----------------|---------------------|-------------------|
| 01-04-2017 | 33 | 130 | 2 | 72 |
| 02-04-2017 | 33.4 | 135 | 3 | 79 |
| 03-04-2017 | 35 | 140 | 4 | 78 |
| 04-04-2017 | 34.8 | 145 | 3 | 67 |
| 05-04-2017 | 36.1 | 150 | 2 | 61 |
| 06-04-2017 | 36.5 | 135 | 3 | 60 |
| 07-04-2017 | 35.4 | 130 | 4 | 74 |
| 08-04-2017 | 35.5 | 125 | 3 | 70 |
| 09-04-2017 | 34.3 | 55 | 3 | 72 |
| 10-04-2017 | 35 | 60 | 3 | 71 |
| 11-04-2017 | 35 | 130 | 3 | 64 |
| 12-04-2017 | 34.4 | 135 | 2 | 73 |
| 13-04-2017 | 29 | 145 | 3 | 75 |
| 14-04-2017 | 28.3 | 150 | 2 | 79 |
| 15-04-2017 | 30.5 | 140 | 2 | 91 |
| 16-04-2017 | 29.3 | 130 | 1 | 88 |
| 17-04-2017 | 30.5 | 145 | 2 | 78 |
| 18-04-2017 | 30.5 | 130 | 2 | 71 |
| 19-04-2017 | 31.3 | 135 | 1 | 70 |

| Date | Temperature (°C) | Wind Direction | Wind Velocity (m/s) | Relative Humidity |
|------------|------------------|----------------|---------------------|-------------------|
| 20-04-2017 | 32.3 | 125 | 2 | 76 |
| 21-04-2017 | 31.7 | 130 | 2 | 69 |
| 22-04-2017 | 32.3 | 135 | 3 | 71 |
| 23-04-2017 | 33.5 | 145 | 3 | 79 |
| 24-04-2017 | 31.9 | 140 | 3 | 71 |
| 25-04-2017 | 33.4 | 65 | 2 | 83 |
| 26-04-2017 | 31.3 | 60 | 2 | 74 |
| 27-04-2017 | 30.8 | 55 | 1 | 87 |
| 28-04-2017 | 31.1 | 60 | 3 | 84 |
| 29-04-2017 | 32.6 | 50 | 3 | 84 |
| 30-04-2017 | 33 | 55 | 3 | 71 |

Source: Primary Data

Table 20: Meteorological data for the month of May 2017

| Date | Temperature (°C) | Wind Direction | Wind Velocity (m/s) | Relative Humidity |
|------------|------------------|----------------|---------------------|-------------------|
| 01-05-2017 | 33.4 | 130 | 3 | 70 |
| 02-05-2017 | 33.8 | 135 | 3 | 79 |
| 03-05-2017 | 33.3 | 140 | 4 | 77 |
| 04-05-2017 | 32 | 135 | 2 | 84 |
| 05-05-2017 | 31.1 | 125 | 2 | 74 |
| 06-05-2017 | 31.5 | 145 | 2 | 78 |
| 07-05-2017 | 30.7 | 140 | 2 | 75 |
| 08-05-2017 | 31.7 | 290 | 3 | 75 |
| 09-05-2017 | 33.4 | 310 | 3 | 75 |
| 10-05-2017 | 33.1 | 320 | 3 | 77 |
| 11-05-2017 | 31.2 | 300 | 2 | 76 |
| 12-05-2017 | 31.5 | 305 | 3 | 76 |
| 13-05-2017 | 32 | 315 | 1 | 83 |
| 14-05-2017 | 28.5 | 310 | 1 | 80 |
| 15-05-2017 | 29.6 | 325 | 2 | 82 |
| 16-05-2017 | 31.2 | 295 | 2 | 78 |
| 17-05-2017 | 30.1 | 300 | 2 | 89 |
| 18-05-2017 | 29.6 | 305 | 4 | 90 |
| 19-05-2017 | 31.2 | 320 | 2 | 76 |
| 20-05-2017 | 32 | 310 | 4 | 85 |
| 21-05-2017 | 33 | 325 | 6 | 81 |
| 22-05-2017 | 32 | 315 | 5 | 84 |
| 23-05-2017 | 32 | 310 | 5 | 79 |

| Date | Temperature (°C) | Wind Direction | Wind Velocity (m/s) | Relative Humidity |
|------------|------------------|----------------|---------------------|-------------------|
| 24-05-2017 | 31.1 | 325 | 6 | 82 |
| 25-05-2017 | 33.3 | 320 | 6 | 80 |
| 26-05-2017 | 33 | 295 | 6 | 77 |
| 27-05-2017 | 32.2 | 295 | 6 | 79 |
| 28-05-2017 | 29.8 | 300 | 5 | 88 |
| 29-05-2017 | 28.2 | 295 | 3 | 84 |
| 30-05-2017 | 32.4 | 300 | 5 | 71 |
| 31-05-2017 | 32.2 | 310 | 4 | 81 |

Source: Primary Data

Table 21: Meteorological data for the month of June 2017

| Date | Temperature (°C) | Wind Direction | Wind Velocity (m/s) | Relative Humidity |
|------------|------------------|----------------|---------------------|-------------------|
| 01-06-2017 | 32.5 | 225 | 5 | 86 |
| 02-06-2017 | 31 | 220 | 4 | 82 |
| 03-06-2017 | 28.6 | 250 | 3 | 79 |
| 04-06-2017 | 30.5 | 245 | 3 | 78 |
| 05-06-2017 | 29.4 | 230 | 2 | 96 |
| 06-06-2017 | 30.6 | 235 | 4 | 81 |
| 07-06-2017 | 32 | 220 | 5 | 68 |
| 08-06-2017 | 31.2 | 235 | 7 | 79 |
| 09-06-2017 | 31.2 | 250 | 6 | 80 |
| 10-06-2017 | 30.7 | 245 | 6 | 85 |
| 11-06-2017 | 32 | 230 | 5 | 88 |
| 12-06-2017 | 31.4 | 215 | 6 | 86 |
| 13-06-2017 | 28.9 | 230 | 5 | 86 |
| 14-06-2017 | 29.7 | 250 | 6 | 91 |
| 15-06-2017 | 27.2 | 225 | 13 | 83 |
| 16-06-2017 | 29 | 235 | 6 | 88 |
| 17-06-2017 | 28.3 | 230 | 6 | 81 |
| 18-06-2017 | 27.2 | 250 | 7 | 84 |
| 19-06-2017 | 27.4 | 215 | 7 | 86 |
| 20-06-2017 | 26.4 | 230 | 7 | 91 |
| 21-06-2017 | 28.3 | 205 | 8 | 93 |
| 22-06-2017 | 25.7 | 220 | 8 | 85 |
| 23-06-2017 | 28.7 | 240 | 9 | 86 |
| 24-06-2017 | 28.2 | 225 | 10 | 86 |

| Date | Temperature (°C) | Wind Direction | Wind Velocity (m/s) | Relative Humidity |
|------------|------------------|----------------|---------------------|-------------------|
| 25-06-2017 | 30.3 | 225 | 9 | 83 |
| 26-06-2017 | 30.6 | 220 | 9 | 86 |
| 27-06-2017 | 27.4 | 225 | 8 | 83 |
| 28-06-2017 | 29 | 220 | 8 | 83 |
| 29-06-2017 | 30.4 | 235 | 7 | 83 |
| 30-06-2017 | 32 | 225 | 5 | 88 |



[VOMD] Madurai
 Windrose Plot [Time Domain: Apr,]
 Period of Record: 01 Apr 2017 - 30 Apr 2017

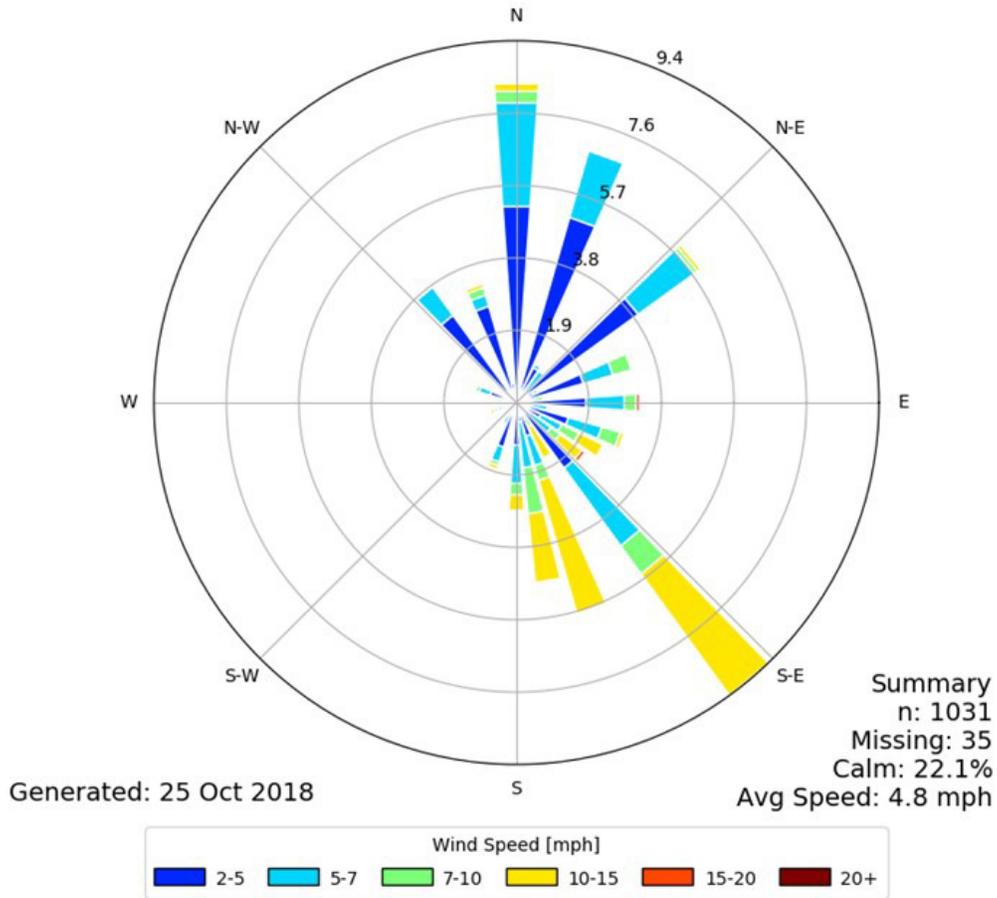


Figure 7: Wind Rose diagram for April 2017



[VOMD] Madurai
Windrose Plot [Time Domain: May,]
Period of Record: 01 May 2017 - 31 May 2017

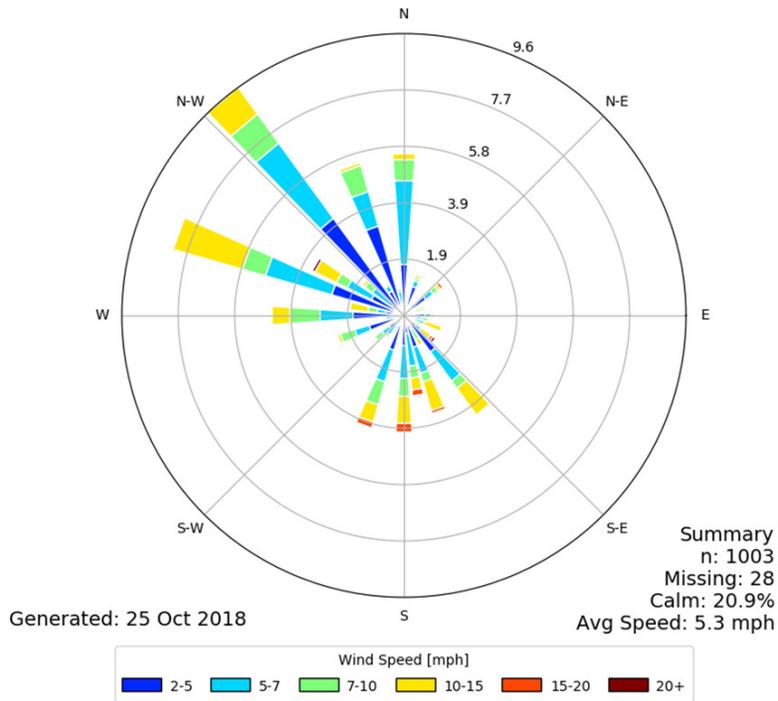


Figure 8: Wind Rose diagram for May 2017



[VOMD] Madurai
Windrose Plot [Time Domain: Jun,]
Period of Record: 01 Jun 2017 - 30 Jun 2017

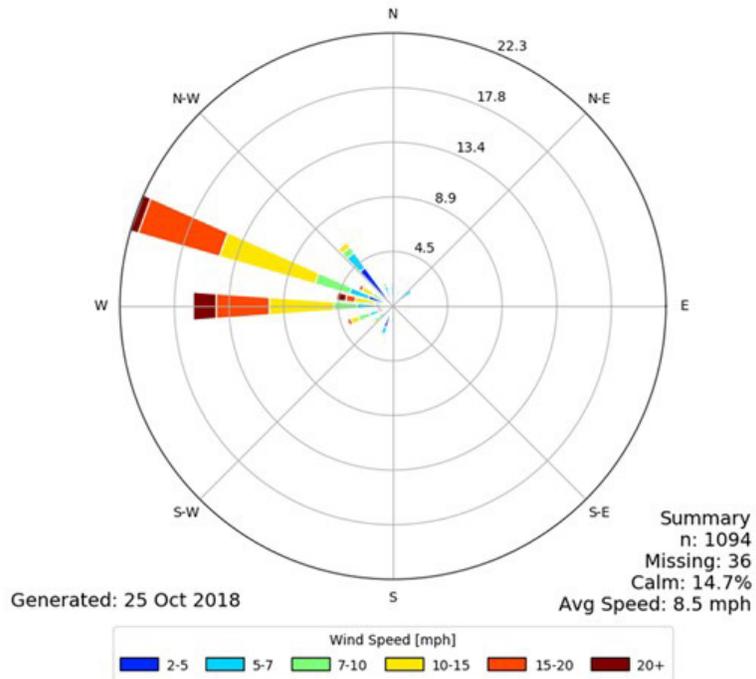


Figure 9: Wind Rose diagram for June 2017

108. The secondary data collected from IMD includes temperature, relative humidity, rainfall and wind speed. The monthly maximum, minimum and average values are presented in **Table 22**. All these parameters are recorded twice a day viz at 0830 and 1730 hours.

109. **Temperature.** The winter season starts from December and continues until the end of February. December and January are the coolest month with the mean daily maximum temperature in winter season around 40.2°C (in the month of May 2013) and the mean daily minimum temperature at 18.7°C (in the month of January 2009). Both the night and day temperatures increases rapidly during the onset of the pre-monsoon season from March to May.

110. **Relative humidity.** The air is generally humid in this region during the post monsoon season. The relative humidity at 0830 hr was observed to be 98 %. Similarly, at 1730 hr, the relative humidity was observed to be of 100 %. In general, the weather during other seasons was observed to be dry.

111. **Rainfall.** The monsoon sets in the month of June and continues up to September and sometime extends up to mid-October. The maximum amount of rainfall (256.3 mm) occurs in the month of November.

Table 22: Meteorological Data (Meteorological Data)

Station: Madurai

Period : 2009- 2013

| Year | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|------|------|------|------|------|------|------|------|------|------|------|------|
| I.ELEMENT: Monthly Mean Maximum Temperature (DEG C) | | | | | | | | | | | | |
| 2009 | 30.2 | 33.4 | 35.2 | 36.1 | 34.5 | 32.5 | 30.3 | 32 | 31.9 | 32.2 | 29.9 | 29.2 |
| 2010 | 30.6 | 33.3 | 36.2 | 37.3 | 35.3 | 32.9 | 31.5 | 30.9 | 31.9 | 31.7 | 29.1 | 28.9 |
| 2011 | 30.8 | 32.3 | 35.3 | 36.2 | 37.7 | 37.6 | 36.7 | 36.0 | 36.1 | 33.7 | 30.4 | 30.3 |
| 2012 | 30.9 | 33.1 | 36.7 | 37.8 | 38.6 | 39.2 | 39.1 | 38.0 | 37.5 | 33.7 | 32.7 | 32.8 |
| 2013 | 33.4 | 33.7 | 36.3 | 40.0 | 40.2 | 37.5 | 38.1 | 36.9 | 35.9 | 36.2 | 32.7 | 31.4 |
| II. ELEMENT: Monthly Highest Maximum Temperature (DEG C) | | | | | | | | | | | | |
| 2009 | 32.5 | 37 | 37.7 | 38 | 37.4 | 37.2 | 35.6 | 33.9 | 35.1 | 34.2 | 33.1 | 32 |
| 2010 | 32.2 | 36 | 37.7 | 39.5 | 37.8 | 37 | 35 | 33.8 | 34.2 | 33.8 | 32.6 | 31.6 |
| 2011 | 32.0 | 35.0 | 36.8 | 38.4 | 39.4 | 40.0 | 40.0 | 38.4 | 37.0 | 36.4 | 32.8 | 31.6 |
| 2012 | 32.2 | 35.4 | 38.8 | 40.5 | 41.1 | 42.0 | 41.5 | 40.5 | 40.1 | 38.6 | 35.6 | 34.2 |
| 2013 | 34.6 | 36.5 | 39.3 | 41.9 | 42.0 | 40.2 | 40.8 | 39.0 | 38.6 | 39.2 | 34.6 | 34.4 |
| III. ELEMENT: Monthly Mean Minimum Temperature (DEG C) | | | | | | | | | | | | |
| 2009 | 18.7 | 19.9 | 22.3 | 24.3 | 23.8 | 23.4 | 22.3 | 22.7 | 22.9 | 22.3 | 22.1 | 20.9 |
| 2010 | 20.3 | 20.8 | 23 | 25.1 | 25 | 23.5 | 22.6 | 22.4 | 22.6 | 22.5 | 21.7 | 20 |
| 2011 | 21.1 | 21.4 | 22.9 | 25.2 | 25.7 | 26.0 | 25.6 | 25.2 | 25.0 | 24.0 | 22.5 | 21.5 |
| 2012 | 20.3 | 21.5 | 24.5 | 25.7 | 26.4 | 26.4 | 26.2 | 25.4 | 25.3 | 23.9 | 23.0 | 22.4 |
| 2013 | 21.5 | 22.0 | 23.7 | 26.3 | 26.6 | 27.0 | 27.0 | 25.4 | 25.3 | 24.5 | 23.8 | 21.9 |
| IV. ELEMENT: Monthly Lowest Minimum Temperature (DEG C) | | | | | | | | | | | | |
| 2009 | 16.1 | 17.8 | 19.7 | 22.6 | 21.4 | 21.2 | 21 | 21.6 | 21.6 | 20.2 | 19 | 17.8 |

| Year | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|--|------|------|------|------|------|------|------|------|------|------|------|------|
| 2010 | 17.4 | 17.4 | 19.8 | 23 | 22 | 21.6 | 21.3 | 21.2 | 20.4 | 20.8 | 19 | 16.6 |
| 2011 | 16.6 | 16.0 | 20.2 | 23.0 | 22.0 | 23.8 | 22.0 | 23.7 | 23.0 | 22.2 | 18.5 | 17.0 |
| 2012 | 16.4 | 18.5 | 20.3 | 22.0 | 22.0 | 24.7 | 24.5 | 23.5 | 23.5 | 22.7 | 20.4 | 19.7 |
| 2013 | 19.0 | 17.0 | 19.1 | 24.0 | 25.1 | 25.2 | 26.0 | 22.6 | 23.6 | 22.0 | 21.6 | 19.4 |
| V. ELEMENT: Monthly Mean R.H. at 0830 HRS IST (%) | | | | | | | | | | | | |
| 2009 | 78 | 68 | 71 | 73 | 79 | 77 | 82 | 82 | 81 | 75 | 86 | 81 |
| 2010 | 80 | 77 | 71 | 73 | 78 | 80 | 81 | 83 | 80 | 82 | 89 | 86 |
| 2011 | 75 | 72 | 70 | 71 | 65 | 61 | 61 | 64 | 62 | 76 | 78 | 77 |
| 2012 | 75 | 69 | 68 | 71 | 64 | 56 | 58 | 63 | 63 | 74 | 73 | 70 |
| 2013 | 70 | 72 | 69 | 65 | 57 | 59 | 54 | 63 | 67 | 66 | 74 | 74 |
| VI. ELEMENT: Monthly Highest R.H. at 0830 HRS IST (%) | | | | | | | | | | | | |
| 2009 | 88 | 88 | 87 | 85 | 88 | 93 | 92 | 96 | 92 | 94 | 96 | 93 |
| 2010 | 91 | 86 | 88 | 81 | 91 | 95 | 91 | 98 | 95 | 96 | 98 | 96 |
| 2011 | 85 | 88 | 87 | 92 | 83 | 87 | 70 | 87 | 75 | 96 | 96 | 91 |
| 2012 | 85 | 82 | 77 | 87 | 73 | 66 | 77 | 79 | 80 | 91 | 87 | 86 |
| 2013 | 77 | 95 | 87 | 75 | 70 | 68 | 62 | 80 | 90 | 93 | 90 | 91 |
| VII. ELEMENT: Monthly Lowest R.H. at 0830 HRS IST (%) | | | | | | | | | | | | |
| 2009 | 68 | 50 | 48 | 61 | 59 | 64 | 69 | 75 | 66 | 49 | 64 | 72 |
| 2010 | 67 | 60 | 53 | 58 | 64 | 66 | 65 | 74 | 64 | 66 | 68 | 75 |
| 2011 | 64 | 54 | 59 | 57 | 51 | 49 | 52 | 52 | 54 | 61 | 58 | 64 |
| 2012 | 60 | 44 | 56 | 60 | 54 | 44 | 49 | 48 | 50 | 58 | 62 | 58 |
| 2013 | 62 | 51 | 51 | 52 | 49 | 49 | 45 | 45 | 49 | 49 | 61 | 62 |
| VIII. ELEMENT: Monthly Mean R.H. at 1730 HRS IST (%) | | | | | | | | | | | | |
| 2009 | 35 | 23 | 27 | 37 | 55 | 61 | 67 | 63 | 67 | 51 | 68 | 57 |
| 2010 | 30 | 29 | 25 | 40 | 58 | 65 | 66 | 67 | 63 | 71 | 73 | 60 |
| 2011 | 56 | 48 | 37 | 49 | 45 | 45 | 49 | 52 | 52 | 66 | 69 | 64 |
| 2012 | 50 | 42 | 37 | 49 | 52 | 47 | 44 | 54 | 51 | 67 | 60 | 57 |
| 2013 | 47 | 46 | 43 | 41 | 44 | 50 | 46 | 55 | 54 | 54 | 61 | 54 |
| IX. ELEMENT: Monthly Highest R.H. at 1730 HRS IST (%) | | | | | | | | | | | | |
| 2009 | 52 | 37 | 70 | 60 | 90 | 91 | 93 | 83 | 76 | 91 | 92 | 97 |
| 2010 | 71 | 40 | 45 | 65 | 85 | 90 | 95 | 85 | 74 | 96 | 95 | 98 |
| 2011 | 77 | 82 | 47 | 95 | 88 | 80 | 84 | 87 | 93 | 90 | 96 | 95 |
| 2012 | 88 | 63 | 45 | 100 | 92 | 95 | 76 | 95 | 80 | 95 | 74 | 92 |
| 2013 | 87 | 72 | 92 | 75 | 65 | 63 | 62 | 95 | 88 | 92 | 89 | 80 |
| X. ELEMENT: Monthly Lowest R.H. at 1730 HRS IST (%) | | | | | | | | | | | | |
| 2009 | 16 | 14 | 11 | 13 | 37 | 41 | 48 | 42 | 45 | 42 | 48 | 33 |
| 2010 | 26 | 15 | 10 | 21 | 44 | 47 | 51 | 46 | 49 | 45 | 52 | 37 |
| 2011 | 46 | 36 | 23 | 30 | 34 | 33 | 40 | 38 | 35 | 46 | 49 | 31 |

| Year | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|--|------|-------|------|-------|------|------|------|-------|------|-------|-------|------|
| 2012 | 33 | 19 | 24 | 36 | 40 | 35 | 33 | 33 | 38 | 38 | 47 | 42 |
| 2013 | 38 | 27 | 26 | 33 | 32 | 40 | 38 | 38 | 40 | 31 | 50 | 39 |
| XI. ELEMENT: Monthly Total Rainfall (MM) | | | | | | | | | | | | |
| 2009 | 0 | 0 | 5.8 | 3.1 | 91 | 8.7 | 42.8 | 55.9 | 68.7 | 51.3 | 227 | 1.3 |
| 2010 | 0.1 | 0 | 0 | 17.7 | 57.8 | 31.9 | 14.8 | 60.1 | 30.8 | 132.2 | 256.3 | 34.7 |
| 2011 | 7.4 | 42.9 | 0.4 | 52.5 | 68.9 | 28.2 | 70.4 | 65.2 | 74.0 | 219.1 | 189.1 | 15.5 |
| 2012 | 13.9 | Trace | 0.4 | 111.1 | 61.8 | 18.3 | 15.8 | 91.2 | 57.1 | 187.9 | 9.6 | 3.5 |
| 2013 | 3.9 | 23.1 | 18.2 | 12.8 | 25.2 | 6.9 | 0.1 | 195.5 | 44.3 | 182.2 | 33.7 | 80.5 |
| XII. ELEMENT: Monthly Mean Windspeed (KMPH) | | | | | | | | | | | | |
| 2009 | 3 | 4 | 4 | 6 | 9 | 10 | 11 | 9 | 9 | 5 | 3 | 4 |
| 2010 | 5 | 4 | 6 | 7 | 9 | 11 | 12 | 12 | 9 | 8 | 3 | 4 |
| 2011 | 5 | 6 | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 5 | 5 |
| 2012 | 5 | 6 | 5 | 4 | 3 | 5 | 5 | 4 | 4 | 4 | 4 | 7 |
| 2013 | 12 | 6 | 6 | 5 | 4 | 6 | 6 | 4 | 4 | 3 | 4 | 5 |

Source: IMD

b. Ambient air quality

112. The prime 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 subproject. The study area represents mostly vacant/ barren land, agricultural and commercial cum residential landuse. This section describes the selection of sampling locations, methodology adopted for sampling, analytical techniques and frequency of sampling. The results of monitoring carried out for study period of April to June 2017 is presented in the following sections.

(i) Selection of Sampling Locations

113. The ambient air quality has been assessed through a scientifically designed ambient air quality monitoring network based on the following considerations:

- Meteorological conditions
- Topography of the study area
- Representative of regional background air quality for obtaining baseline status
- Representatives of likely impact areas

114. Ambient Air Quality Monitoring (AAQM) stations were set up at eight locations with due consideration to the above-mentioned points. The AAQM locations are depicted in **Figure 11**.

(ii) Particulate Matter (PM₁₀ & PM_{2.5})

115. Based on the outcome of the analysis, the PM₁₀ and PM_{2.5} varied from 31 to 58 µg/m³ and 14 to 26 µg/m³ respectively. The observed values are below than the stipulated limits of AAQ standards. The results are presented in **Table 23** and **Table 24** respectively.

Table 23: Ambient Air Quality Status (PM₁₀) – (April – June 2017)

Averaging Time: 24 Hrs

Unit: µg/m³

| Sl. No. | Sampling Station | Max | Min | Arithmetic Mean | Standard Deviation | 98 th Percentile |
|---------|------------------|-----|-----|-----------------|--------------------|-----------------------------|
| AAQ1 | Lower Camp | 53 | 41 | 50 | 3.6 | 53 |
| AAQ2 | Gudalur | 53 | 46 | 50 | 2.8 | 53 |
| AAQ3 | Cumbum | 58 | 43 | 48 | 3.8 | 58 |
| AAQ4 | Chinnamanur | 51 | 40 | 47 | 3.6 | 51 |
| AAQ5 | Theni | 49 | 38 | 43 | 2.7 | 49 |
| AAQ6 | Pannaipatti | 41 | 34 | 38 | 2.3 | 41 |
| AAQ7 | Samayanallur | 43 | 31 | 39 | 3.7 | 43 |
| AAQ8 | Madurai | 47 | 38 | 43 | 3.4 | 47 |

Note: PM₁₀ Permissible limit for industrial, Residential, Rural and other area is 100 µg/m³

Table 24: Ambient Air Quality Status (PM_{2.5}) – (April – June 2017)

Averaging Time: 24 Hrs

Unit: µg/m³

| Sl. No. | Sampling Station | Max | Min | Arithmetic Mean | Standard Deviation | 98 th Percentile |
|---------|------------------|-----|-----|-----------------|--------------------|-----------------------------|
| AAQ1 | Lower Camp | 26 | 21 | 24 | 1.6 | 26 |
| AAQ2 | Gudalur | 25 | 18 | 23 | 1.8 | 25 |
| AAQ3 | Cumbum | 23 | 18 | 22 | 1.5 | 23 |
| AAQ4 | Chinnamanur | 25 | 18 | 21 | 1.8 | 25 |
| AAQ5 | Theni | 21 | 16 | 19 | 1.2 | 21 |
| AAQ6 | Pannaipatti | 20 | 15 | 17 | 1.4 | 20 |
| AAQ7 | Samayanallur | 21 | 14 | 18 | 2.0 | 21 |
| AAQ8 | Madurai | 22 | 16 | 19 | 1.8 | 22 |

Note: PM_{2.5} Permissible limit for industrial, Residential, Rural and other area is 60 µg/m³

(iii) Sulphur Dioxide (SO₂)

116. From the observation, the recorded SO₂ concentration was in the range between 07 to 19 µg/m³. Maximum concentration was recorded in Chinnamanur (19 µg/m³) and minimum concentration was recorded in Pannaipatti (7 µg/m³). The results are shown in the **Table 25**.

Table 25: Ambient Air Quality Status (SO₂) - (April – June 2017)

Averaging time: 24 hrs.

Unit :µg/m³

| Sl. No. | Sampling Station | Max | Min | Arithmetic Mean | Standard Deviation | 98 th Percentile |
|---------|------------------|-----|-----|-----------------|--------------------|-----------------------------|
| AAQ1 | Lower Camp | 18 | 13 | 15 | 1.6 | 18 |
| AAQ2 | Gudalur | 13 | 08 | 11 | 1.6 | 13 |
| AAQ3 | Cumbum | 10 | 07 | 9.0 | 1.0 | 10 |

| Sl. No. | Sampling Station | Max | Min | Arithmetic Mean | Standard Deviation | 98 th Percentile |
|---------|------------------|-----|-----|-----------------|--------------------|-----------------------------|
| AAQ4 | Chinnamanur | 19 | 09 | 12 | 2.3 | 19 |
| AAQ5 | Theni | 15 | 11 | 13 | 1.4 | 15 |
| AAQ6 | Pannaipatti | 12 | 07 | 10 | 1.6 | 12 |
| AAQ7 | Samayanallur | 17 | 12 | 14 | 1.7 | 17 |
| AAQ8 | Madurai | 16 | 10 | 13 | 1.6 | 16 |

Note: Permissible limit of SO₂ for Industrial, Residential, Rural and other area is 80 µg/m³

(iv) Oxides of Nitrogen (NO₂)

117. The Nitrogen dioxide concentration in the subproject area was in the range of 13 to 34 µg/ m³. The maximum concentration was recorded in Lower camp (30 µg/ m³) and minimum concentration was recorded in Cumbum (13 µg/ m³) presented in **Table 26**.

Table 26: Ambient Air Quality Status (NO₂)(April – June 2017)

Averaging Time: 24 hrs.

Unit: µg/m³

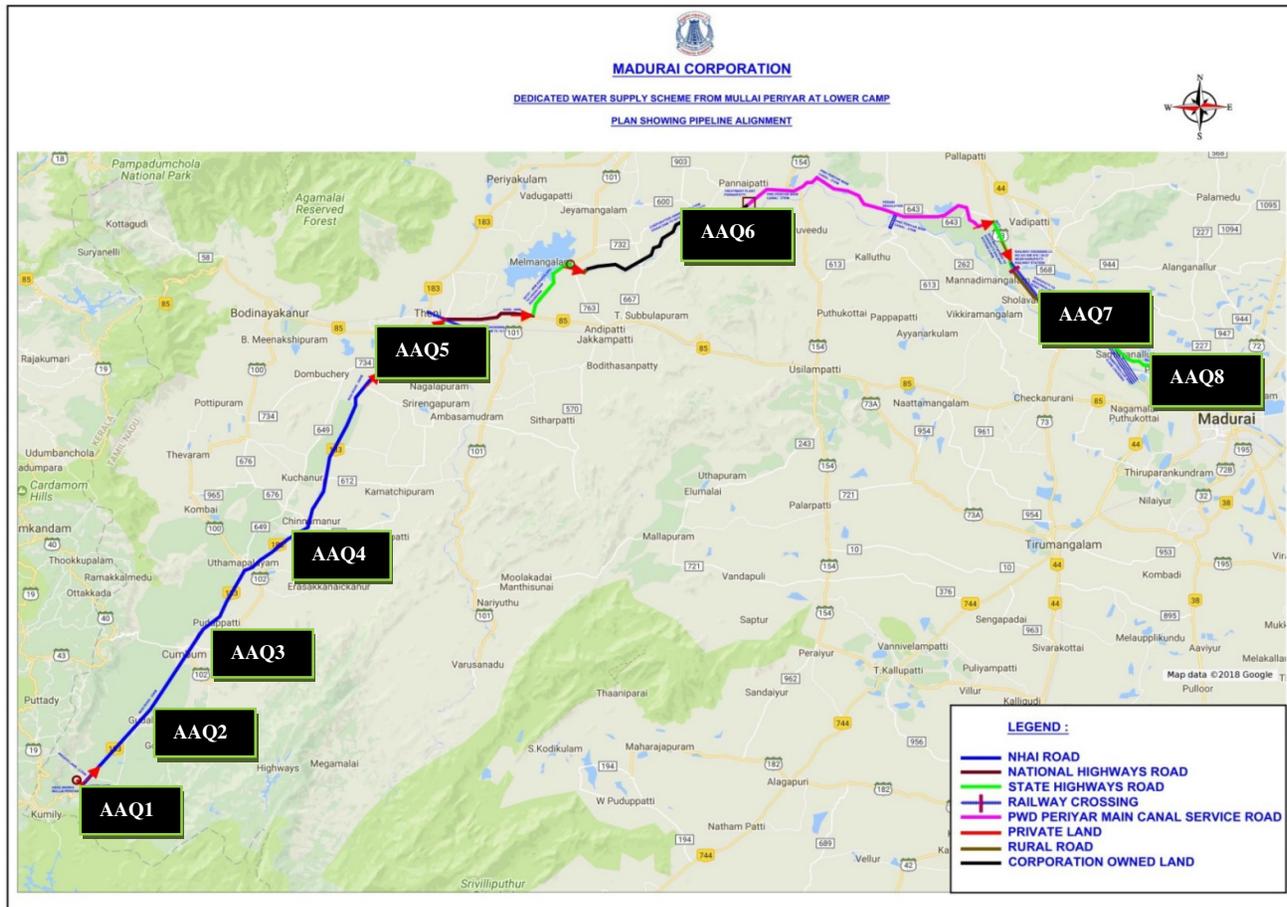
| Sl. No. | Sampling Station | Max | Min | Arithmetic Mean | Standard Deviation | 98 th Percentile |
|---------|------------------|-----|-----|-----------------|--------------------|-----------------------------|
| AAQ1 | Lower Camp | 34 | 24 | 27 | 2.8 | 34 |
| AAQ2 | Gudalur | 20 | 17 | 19 | 1.1 | 20 |
| AAQ3 | Cumbum | 16 | 13 | 15 | 1.0 | 16 |
| AAQ4 | Chinnamanur | 21 | 15 | 19 | 1.6 | 21 |
| AAQ5 | Theni | 24 | 18 | 22 | 2.9 | 24 |
| AAQ6 | Pannaipatti | 18 | 14 | 17 | 1.4 | 18 |
| AAQ7 | Samayanallur | 30 | 21 | 26 | 2.6 | 30 |
| AAQ8 | Madurai | 27 | 18 | 24 | 3.2 | 27 |

Note: Permissible limit of NO₂ for Industrial, Residential, Rural and other area is 80 µg/m³



Figure 10: Ambient Air Quality Sampling Photos:

Figure 11: AAQ Sampling Location Map



| Station | Ground Water Sampling Location |
|---------|--------------------------------|
| AAQ 1 | Lower Camp |
| AAQ 2 | Gudalur |
| AAQ 3 | Cumbum |
| AAQ 4 | Chinnamanur |
| AAQ 5 | Theni |
| AAQ 6 | Pannaipatti |
| AAQ 7 | Samayanallur |
| AAQ 8 | Madurai |

c. Noise Environment

118. The main objective of noise monitoring in the study area is to establish the baseline noise levels, and assess the impact of the total noise expected to be generated by the construction and operation of the proposed activity.

(i) Identification of Sampling Locations

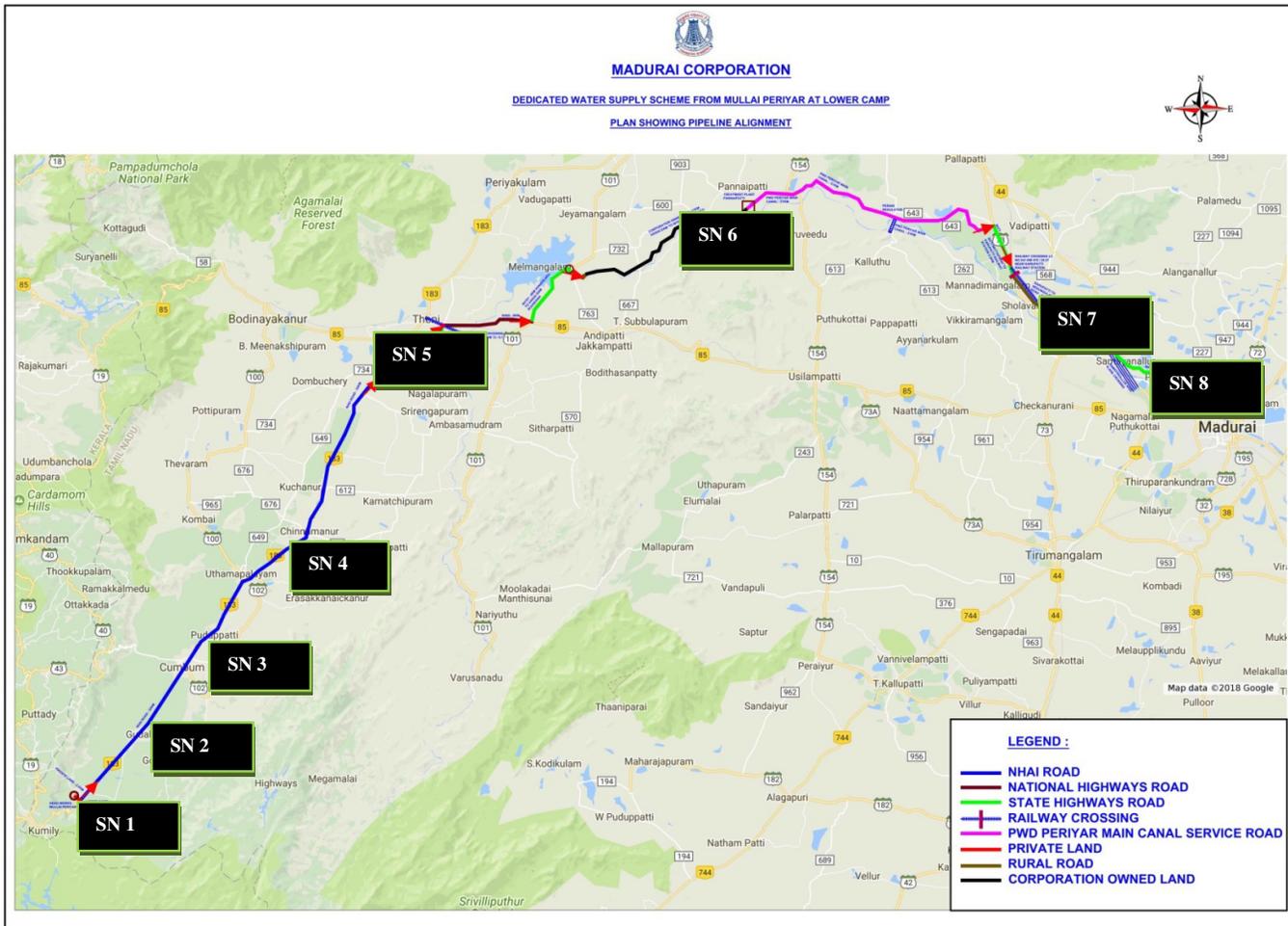
119. A preliminary reconnaissance survey has been undertaken at 8 locations to identify the major noise generating sources in the area and accordingly sampling locations are fixed (refer **Figure 12**). The noise levels at each location were recorded for 24 hours. The outcome of the monitoring is given in the **Table 27**.

Table 27: Equivalent Day-Night Noise Level Details

| Station No. | Sampling Stations | Equivalent Levels dB(A) | | | |
|-------------|-------------------|-------------------------|------|------------|------|
| | | Day Time | | Night Time | |
| | | Min | Max | Min | Max |
| SN1 | Lower Camp | 63.5 | 71.8 | 57.2 | 67.9 |
| SN2 | Gudalur | 61.9 | 72.5 | 59.8 | 69.1 |
| SN3 | Cumbum | 62.9 | 72.3 | 55.8 | 68.9 |
| SN4 | Chinnamanur | 65.1 | 71.9 | 57.2 | 64.5 |
| SN5 | Theni | 66.1 | 73.9 | 56.8 | 64.5 |
| SN6 | Pannaipatti | 61.9 | 72.9 | 51.8 | 61.8 |
| SN7 | Samayanallur | 59.9 | 73.9 | 57.9 | 63.9 |
| SN8 | Madurai | 61.8 | 73.1 | 56.8 | 63.8 |

120. The daytime noise levels ranges between 61.8 dB(A) and 73.9 dB(A). The maximum value 73.9 dB (A) was recorded at Theni and the minimum value (61.8 dB (A)) was recorded at Madurai. The nighttime noise levels ranges between 51.8 dB (A) and 69.1 dB (A). The maximum value (69.1dB (A)) was recorded at Gudalur and the minimum value (51.8 dB (A)) was recorded at Pannaipatti.

Figure 12: Noise Sampling Location Map



| Stations | Ground Water Sampling Location |
|----------|--------------------------------|
| SN1 | Lower Camp |
| SN 2 | Gudalur |
| SN 3 | Cumbum |
| SN 4 | Chinnamanur |
| SN 5 | Theni |
| SN 6 | Pannaipatti |
| SN 7 | Samayanallur |
| SN 8 | Madurai |

d. Water Quality Monitoring

121. The purpose of this study is to assess the water quality characteristics in the subproject area. Understanding the water quality is essential in preparation of report and to identify critical issues with a view to suggest appropriate mitigation measures for implementation. The information required has been collected through primary surveys and secondary sources.

122. **GroundWater Quality:** Water samples were collected from eight locations. These samples were taken as grab samples and were analyzed for physico-chemical parameters to compare with the standards for drinking water (IS:10500).

- The analysis results indicate that the pH ranges in between 7.0 to 7.8, which is well within the specified standard (6.5 to 8.5). The maximum pH of 7.8 was observed at Gudalur and the minimum pH of 7.0 was observed at Chinnamanur and Samayanallur.
- Total hardness was observed to be ranging from 44 to 1222 mg/l. The maximum hardness was recorded at Pannaipatti and the minimum was recorded at Samayanallur.
- Chlorides were found to be in the range of 179 mg/l to 975 mg/l, the maximum concentration of chlorides was observed at Pannaipatti and whereas the minimum value was observed at Cumbum.
- Sulphates were found to be in the range of 12 mg/l to 244 mg/l. The maximum value observed at Pannaipatti whereas the minimum value observed at Samayanallur.
- The Total Dissolved Solids (TDS) concentrations were found to be ranging in between 89 to 3680 mg/l, the maximum TDS observed at Pannaipatti and minimum concentration of TDS observed at Samayanallur.

123. The locations of ground water samples are shown in Figure 14 and the results of ground water samples are given in **Table 28**.

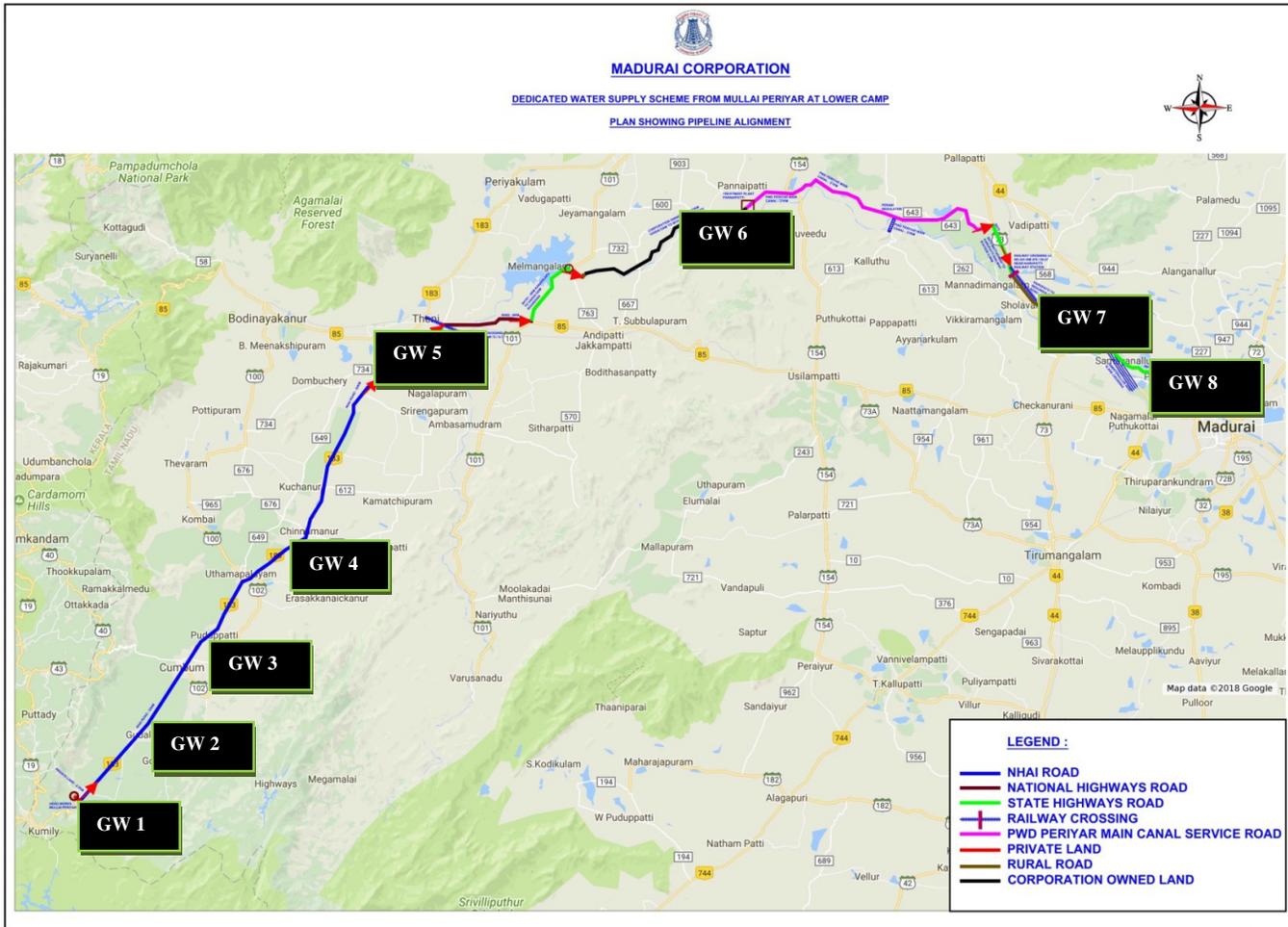
Table 28: Results of water quality parameters

| Parameters | Units | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | GW7 | GW8 |
|---------------------------------------|----------|------|------|------|------|------|------|-------|------|
| Calcium as Ca | mg/l | 182 | 90 | 182 | 339 | 151 | 306 | 50 | 154 |
| Chlorides as Cl | mg/l | 188 | 487 | 179 | 901 | 272 | 975 | 220 | 247 |
| Color | Hazen | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <0.1 |
| Electrical Conductivity | µmhos/cm | 1535 | 1431 | 1372 | 2410 | 1798 | 5661 | 1337 | 1498 |
| Fluoride as F | mg/l | 0.4 | 0.4 | 0.2 | 0.4 | 1.2 | 0.6 | <0.1 | 0.4 |
| Iron as Fe | mg/l | 0.16 | 0.12 | 0.09 | 0.18 | 0.11 | 0.51 | <0.01 | 0.14 |
| Magnesium as Mg | mg/l | 67 | 34 | 45 | 85 | 58 | 112 | 23 | 37 |
| Nitrate Nitrogen as NO ₃ | mg/l | 2.2 | 1.6 | 1.8 | 3.2 | 2.2 | 4.8 | <1.0 | 2.0 |
| pH | - | 7.3 | 7.8 | 7.6 | 7.0 | 7.2 | 7.1 | 7.0 | 7.1 |
| Sulphates | mg/l | 18 | 106 | 26 | 114 | 114 | 244 | 12 | 28 |
| Total Alkalinity as CaCO ₃ | mg/l | 460 | 332 | 277 | 138 | 449 | 510 | 55 | 389 |
| Total Dissolved Solids | mg/l | 998 | 930 | 892 | 1564 | 1169 | 3680 | 89 | 973 |
| Total Hardness | mg/l | 619 | 365 | 640 | 1191 | 613 | 1222 | 44 | 675 |
| Turbidity | NTU | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |



Figure 13: Water Quality Sampling Photos

Figure 14: Water Sampling Locations



| Stations | Ground Water Sampling Location |
|----------|--------------------------------|
| GW1 | Lower Camp |
| GW 2 | Gudalur |
| GW 3 | Cumbum |
| GW 4 | Chinnamanur |
| GW 5 | Theni |
| GW 6 | Pannaipatti |
| GW 7 | Samayanallur |
| GW 8 | Madurai |

e. Soil quality

124. The study on the soil profile establishes the baseline characteristics and identifies the incremental concentrations. The sampling locations have been identified with the following objectives:

- To determine the baseline soil characteristics of the study area;
- To determine the impact on soil more importantly from agricultural productivity point of view.

125. Eight locations in the study area were selected for soil sampling. At each location, soil samples were collected from three different depths viz. 30 cm, 60 cm and 90 cm below the surface and homogenized. The homogenized samples were taken to identify soil conditions. The samples were collected by ramming a core-cutter into the soil up to a depth of 90 cm. Simultaneously, in-situ infiltration test using double ring infiltrometer was carried out at all location to determine the permeability. The details of the sampling location is shown in **Figure 15** and outcome of the results are given in **Table 29**.

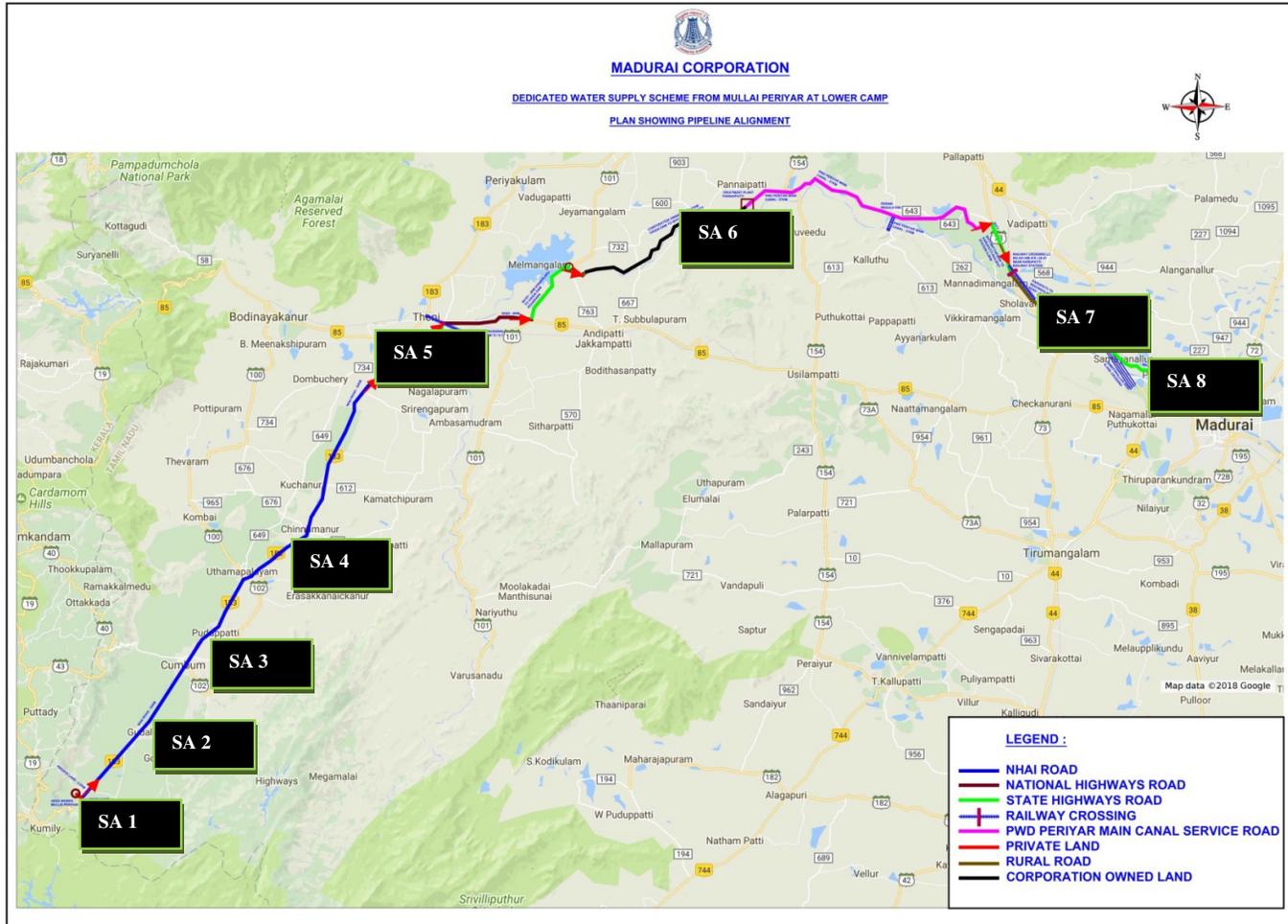
- It has been observed that the pH of the soil in the study area ranged from 6.8 to 8.4 the maximum pH value of 8.4 was observed at Samayanallur, whereas the minimum value of 6.0 was observed at Gudalur & Cumbum.
- The electrical conductivity was observed to be in the range of 95 mmhos/cm to 425 mmhos/cm, with the maximum observed at Lower camp with the minimum observed at Gudalur & Cumbum.
- The nitrogen values range between 1.0 to 3.4%, with the maximum observed at Lower camp with the minimum observed at Madurai.
- The phosphorus values < 0.1 kg/ha, indicating that the phosphorus content in the study area falls in average sufficient to more than Sufficient
- The potassium values range between 18 – 108kg/acre, with the maximum observed at Madurai with the minimum observed at Gudalur.

Table 29: Results of soil quality parameters

| S.no | Parameters | Units | Results | | | | | | | |
|------------------|------------|----------|------------|------------|------------|------------|------------|------------|------------|------------|
| | | | SA-1 | SA-2 | SA-3 | SA-4 | SA-5 | SA-6 | SA-7 | SA-8 |
| 1 | pH | No. | 8.0 | 6.8 | 6.8 | 6.9 | 8.3 | 7.4 | 8.4 | 7.2 |
| 2 | EC | mmhos/cm | 425 | 95 | 95 | 97 | 178 | 134 | 216 | 160 |
| 3 | Texture | --- | Sandy Loam |
| Macro Nutrients: | | | | | | | | | | |
| 4 | Nitrogen | % | 3.4 | 1.2 | 1.4 | 0.8 | 0.4 | 1.4 | 1.2 | 1.0 |
| 5 | Phosphorus | % | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 | < 0.1 |
| 6 | Potassium | Kg/Acre | 38 | 18 | 58 | 12 | 64 | 92 | 26 | 108 |
| Micro Nutrients: | | | | | | | | | | |
| 7 | Iron | mg/Kg | 14164 | 8868 | 9344 | 9144 | 11615 | 11618 | 10144 | 9654 |
| 8 | Manganese | mg/Kg | 165 | 121 | 166 | 116 | 194 | 208 | 158 | 156 |
| 9 | Zinc | mg/Kg | 1.6 | 5.4 | 14 | 1.4 | 10 | 12 | 1.0 | 1.0 |
| 10 | Copper | mg/Kg | 1.9 | 1.0 | 6.9 | 1.0 | 1.4 | 1.4 | 1.2 | 4.4 |



Figure 15: Soil Sampling Locations



| | Soil Sampling Locations |
|------|-------------------------|
| SA 1 | Lower Camp |
| SA 2 | Gudalur |
| SA 3 | Cumbum |
| SA 4 | Chinnamanur |
| SA 5 | Theni |
| SA 6 | Pannaipatti |
| SA 7 | Samayanallur |
| SA 8 | Madurai |

f. Land environment

126. **Land Use Pattern.**
Land use pattern for Madurai City as existed in 1994, 2001 and in 2021 is as given in the following **Table 30.**

Table 30: Details of Land Use Pattern

| Sl.No | Type of Land Use | Area in SqKm | | | %to the developed area | | |
|-------|-----------------------------|--------------|--------------|--------------|------------------------|-------|-------|
| | | 1994 | 2001 | 2021 | 1994 | 2001 | 2021 |
| 1 | Residential | 21.45 | 21.79 | 24.75 | 57.49 | 57.49 | 50.36 |
| 2 | Commercial | 1.94 | 4.14 | 4.7 | 5.32 | 5.32 | 9.57 |
| 3 | Industrial | 2.1 | 3.12 | 3.12 | 5.63 | 5.63 | 6.35 |
| 4 | Education | 1.72 | 3.62 | 3.62 | 4.61 | 4.61 | 7.36 |
| 5 | Public&Semi-Public | 2.65 | 4.66 | 4.66 | 7.1 | 7.1 | 9.49 |
| 6 | Transportation/Circulation | 7.41 | 8.29 | 16.86 | 19.85 | 19.85 | 8.29 |
| 7 | Sub-Total(DevelopedArea) | 37.32 | 45.61 | 49.14 | 100 | 100 | 100 |
| 8 | WaterBodies | 5.03 | 2.07 | 2.07 | -- | -- | -- |
| 9 | Agriculture | 9.48 | 4.14 | 0.61 | -- | -- | -- |
| 10 | Sub-Total(Un-DevelopedArea) | 14.06 | 6.21 | 2.68 | -- | -- | -- |
| | Total | 51.82 | 51.96 | 51.96 | -- | -- | -- |

g. Topography

127. In general, the topography of the Madurai City Corporation is gently sloped towards Vaigai River. There are small hillocks within the Madurai District, but not within the city limit (MMC). These are located at Anaimalai, Nagamalai, Pasumalai and Sikandamalai and the distant ranges of Sirumalai, Karandamalai, Alagar Malai and Aaliur Hill, which form the panoramic landscape features.

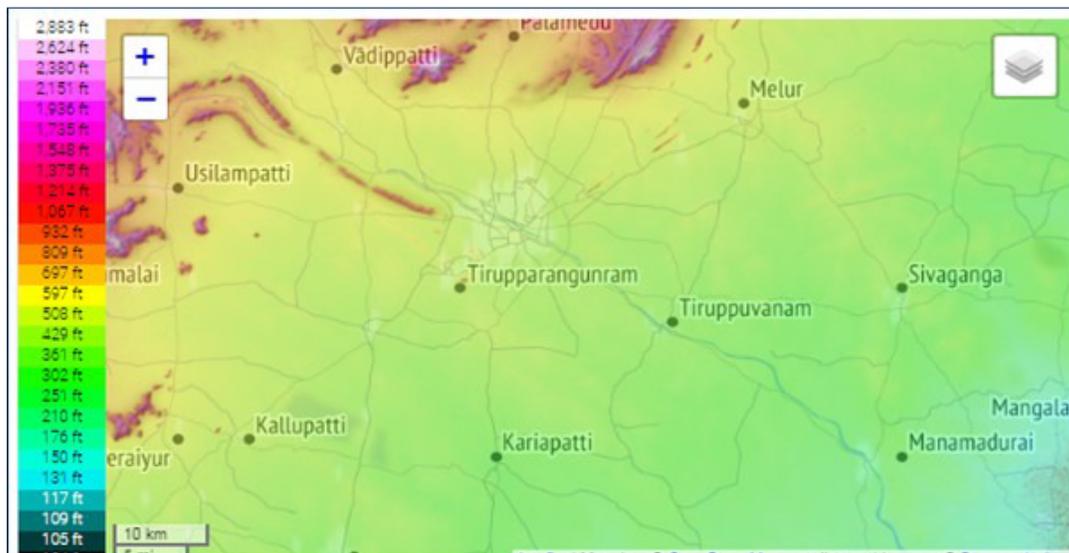


Figure 16: Topographic map of Madurai city

h. Drainage

128. Vaigai, a major ephemeral river originates in Western Ghats of Theni District flow in NW-SE direction, in the central part of the district. In addition, tributaries of Vaipar and Gundar drain in south-western part of the district, while the tributaries of Pambar drained in northeastern part. The general flow direction of the drainage is NW-SE.

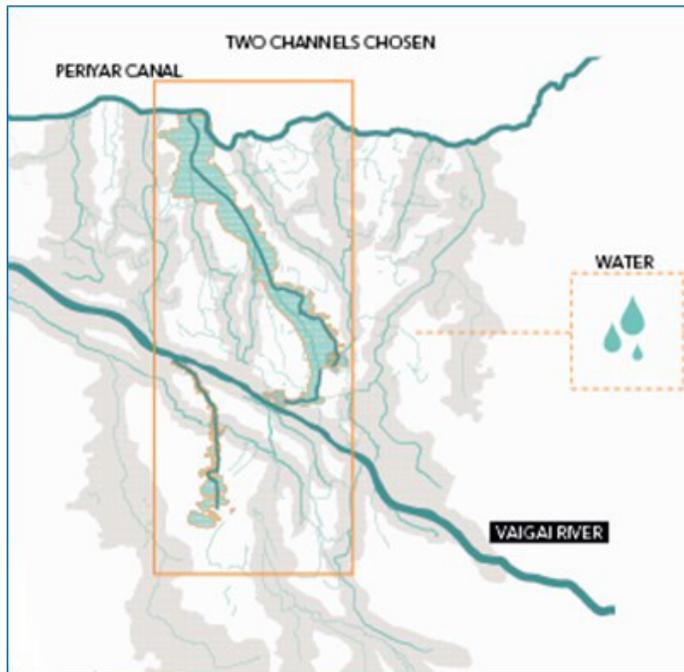


Figure 17: Drainage map of Madurai city

C. Biological Environment

129. The main objective of the study is to provide necessary information on floristic structure of the study area. The climatic and biotic variations and composition of species, which are adapted to these variations, have resulted in different vegetation covers. The tree species, shrubs, herbs, climbers and grasses were documented during the study period. The tree species observed in the study area are listed in **Table 31**; the shrubs observed in the study area are documented in **Table 32**; the herbs & grasses in **Table 33** and climbers in **Table 34**.

Tree species:

130. 52 tree species belonging to 24 families were observed in the study area (**Table 31**). The dominant tree species in the study area are *Anacardium occidentale*, *Coccoloba nucifer*, *Albizia lebbek*, *Delonix regia*, *Casuarina equisetifolia*, *Musa paradisiaca*, *Ficus benghalensis*, *Anacardium occidentale*, *Phoenix sylvestris* and *Erythrina indica*.

Table 31: List of tree species

| S.No | Family Name | Botanical Name | Vernacular name |
|------|------------------------|------------------------------|-----------------|
| 1 | <i>Anacardiaceae</i> | <i>Mangifera indica</i> | Mamaram |
| | | <i>Lannea coromandelica</i> | Otti |
| 2 | <i>Annonaceae</i> | <i>Polyalthia longifolia</i> | Nettilingam |
| 3 | <i>Arecaceae</i> | <i>Borassus flabellifer</i> | Panai |
| | | <i>Caryota urens</i> | Kuntharpanai |
| | | <i>Coccoloba nucifera</i> | Thennai |
| | | <i>Roystonea regia</i> | Arasapanai |
| | | <i>Spathodea campanulata</i> | Patadi |
| 4 | <i>Apocynaceae</i> | <i>Alstonia scholaris</i> | Yelilai pillai |
| | | <i>Plumeria alba</i> | Perunkalli |
| | | <i>Plumeria rubra</i> | Perunkalli |
| 5 | <i>Caesalpiniaceae</i> | <i>Cassia fistula</i> | Sarakondrai |
| | | <i>Cassia siamea</i> | Manjalkondrai |

| S.No | Family Name | Botanical Name | Vernacular name |
|------|----------------------|--------------------------------|---------------------|
| | | <i>Peltophorum pterocarpum</i> | Perunkondrai |
| | | <i>Tamarindus indica</i> | Puliyamaram |
| 6 | <i>Cannabaceae</i> | <i>Trema orientalis</i> | Yeralai |
| 7 | <i>Caricaceae</i> | <i>Carica papaya</i> | Pappali |
| 8 | <i>Casuarinaceae</i> | <i>Casuarina equisetifolia</i> | Savukku |
| 9 | <i>Combretaceae</i> | <i>Terminalia catapa</i> | Patham |
| 10 | <i>Euphorbiaceae</i> | <i>Euphorbia tirucalli</i> | Kalli |
| 11 | <i>Fabaceae</i> | <i>Acacia auriculiformis</i> | Kathi savukku |
| | | <i>Bauhinia purpurea</i> | Mantharai |
| | | <i>Delonix regia</i> | Semmayir kondrai |
| | | <i>Gliricidia sepium</i> | Seemai agathi |
| | | <i>Leucaena leucocephala</i> | Periyathagarai |
| | | <i>Pongamia glabra</i> | Pungan |
| | | <i>Pongamia pinnata</i> | Pungan |
| 12 | <i>Lamiaceae</i> | <i>Gmelina arborea</i> | Kumalamaram |
| | | <i>Tectona grandis</i> | Thekku |
| 13 | <i>Lecythidaceae</i> | <i>Barringtonia acutangula</i> | senkadampu |
| 14 | <i>Malvaceae</i> | <i>Thespesia populnea</i> | Poovarasu |
| 15 | <i>Meliaceae</i> | <i>Azadiracta indica</i> | Vembu |
| 16 | <i>Mimosaceae</i> | <i>Acacia nilotica</i> | Karuvelai |
| | | <i>Albizia lebbek</i> | Vagai |
| | | <i>Pithecellobium dulce</i> | Kodikai |
| | | <i>Samanea saman</i> | Thungumunji maram |
| 17 | <i>Moraceae</i> | <i>Ficus bengalensis</i> | Aalamaram |
| | | <i>Ficus hispita</i> | Peiaththi |
| | | <i>Ficus racemosa</i> | Anai athi |
| | | <i>Ficus religiosa</i> | Arasamaram |
| 18 | <i>Moringaceae</i> | <i>Moringa oleifera</i> | Murungai |
| | | <i>Morinda tinctoria</i> | Manjanethi |
| 19 | <i>Musaceae</i> | <i>Musa paradisiacal</i> | Valai |
| 20 | <i>Myristicaceae</i> | <i>Myristica fragrans</i> | Sathikai |
| 21 | <i>Myrtaceae</i> | <i>Callistemon lanceolatus</i> | <i>Bottle brush</i> |
| | | <i>Eucalyptus</i> | Thailamaram |
| | | <i>Syzygium cumini</i> | Naval |
| 22 | <i>Rubiaceae</i> | <i>Neolamarckia cadamba</i> | Cadampam |
| 23 | <i>Rutaceae</i> | <i>Aegle marmelos</i> | Vilvam |
| | | <i>Murraya exotica</i> | - |
| | | <i>Murraya koenigii</i> | Karuvepillai |
| 24 | <i>Sapotaceae</i> | <i>Manilkara zapota</i> | Sapotta |

Shrub Species:

131. During the survey a total of 26 shrub species belonging to 17 families from the study area were observed. The dominant shrubs in the study area were *Calotropis gigantea*, *Calotropis procera*, *Tecoma stans*, *Jatropha curcas*, *Ricinus communis*, *Ipomoea carnea*, *Ziziphus jujube*, *Solanum torvum* and *Ricinus communis*. The shrubs observed in the study area are given in the **Table 32**.

Table 32: List of shrub species

| S.No | Family Name | Botanical Name | Vernacular name |
|------|----------------|-----------------------------------|------------------|
| 1 | Apocynaceae | <i>Nerium indicum</i> | Arali |
| | | <i>Nerium oleander</i> | Sevvarali |
| | | <i>Tabernaemontana divaricata</i> | Nanthiyavattai |
| 2 | Asclepidaceae | <i>Calotropis Gigantea</i> | Vellerukku |
| | | <i>Calotropis procera</i> | Erukku |
| | Bignoniaceae | <i>Tecoma stans</i> | Nagasambagam |
| 3 | Convolvulaceae | <i>Ipomoea carnea</i> | Kulai kuchi |
| 4 | Euphorbiaceae | <i>Jatropha curcas</i> | Kattamanakku |
| | | <i>Ricinus communis</i> | Amanakku |
| 5 | Leguminaceae | <i>Bauhinia racemosa</i> | kattathi |
| 6 | Lythraceae | <i>Lawsonia innemis</i> | Maruthani |
| | Malvaceae | <i>Hibiscus rosa-sinensis</i> | Semparuthi |
| 7 | Mimosaceae | <i>Projopis juliflora</i> | Seemai karuvelam |
| 8 | Nyctaginaceae | <i>Bougainvillea spectabilis</i> | Kakitha poo |
| 9 | Pandanaceae | <i>Pandanus parkinson</i> | Thazhai |
| 10 | Rhamnaceae | <i>Ziziphus rugosa</i> | llanthai |
| 11 | Rosaceae | <i>Rosa indica</i> | Rose |
| 12 | Rubiaceae | <i>Ixora coccinia</i> | Idly poo |
| 13 | Rutaceae | <i>Citrus medica</i> | Elumichai |
| 14 | Solanaceae | <i>Datura stramonium</i> | Umaththai |
| 15 | Solanaceae | <i>Xanthium strumarium</i> | Marulumaththai |
| 16 | Verbinaceae | <i>Clerodendrum inerme</i> | Sangam |
| | | <i>Duranta erecta</i> | |
| | | <i>Lantana camara</i> | Unni sedi |
| | | <i>Vitex negundo</i> | Notchi |

Herb Species

132. At the time of survey, the herb and grasses are observed to be dried (during summer season); however, few herbs and grass are observed in the surroundings of the riverbank and ponds/ tanks. As per the inventory, there are a total 42 herb and grass species belonging to 23 families were recorded (**Table 33**). Some of the common species identified are *Nymphaea* sp, *Ruellia tuberosa*, *Typha angustifolia*, *Aerva lanata* and *Nymphaea* sp.

Table 33: List of Herbs and Grasses in the study area

| S.No | Family Name | Botanical Name | Vernacular name |
|------|-----------------|--------------------------------|-----------------------|
| 1 | Acanthaceae | <i>Asteracantha longifolia</i> | Neermulli |
| 2 | Amaranthaceae | <i>Achyranthes aspera</i> | Nayuruvi |
| | | <i>Celosia argentea</i> | Kozhi poo |
| 3 | Apocynaceae | <i>Catharanthus roseus</i> | Nithya kalyani |
| 4 | Araceae | <i>Colocasia esculenta</i> | Samai kilangu |
| 5 | Asteraceae | <i>Ageratum conyzoides</i> | Appakkoti |
| | | <i>Eclipta alba</i> | Karisalan kanni |
| | | <i>Tridax procumbens</i> | Thatha poochedi |
| | | <i>Wedelia trilobata</i> | Manjal karisalankanni |
| 6 | Brassicaceae | <i>Rapanus sativus</i> | Mullangi |
| 7 | Caesalpiniaceae | <i>Cassia tora</i> | Sirukondrai |
| | | <i>Cassia alata</i> | Seemai agathi |
| 8 | Convolvulaceae | <i>Merremia emarginata</i> | Elikkadhu-keerai |
| 9 | Cyperaceae | <i>Cyperus rotundus</i> | Korai |
| 10 | Euphorbiaceae | <i>Acalypha indica</i> | kuppaimeni |

| S.No | Family Name | Botanical Name | Vernacular name |
|------|-----------------|--------------------------------|----------------------|
| | | <i>Euphorbia hirta</i> | Amman pacharisi |
| 11 | Fabaceae | <i>Tephrosia purpurea</i> | Kolinci |
| 12 | Lamiaceae | <i>Hyptis suaveolens</i> | Nattapoochedi |
| | | <i>Leucas aspera</i> | Thumbai |
| 13 | Nelumbonaceae | <i>Nelumbo nucifera</i> | Thamarai |
| 14 | Nyctaginaceae | <i>Boerhavia diffusa</i> | Mukkuruttai kodi |
| 15 | Nymphaeaceae | <i>Nymphaea odorata</i> | Alli |
| 16 | Pedaliaceae | <i>Pedaliium Murex</i> | Yanai nerunchi |
| 17 | Poaceae | <i>Bambusa bambos</i> | Moongil |
| | | <i>Cynodon dactylon</i> | Arugam pul |
| | | <i>Heteropogon contortus</i> | - |
| | | <i>Oriza sativa</i> | Nel |
| | | <i>Panicum miliare</i> | samai |
| | | <i>Paspalum scrobiculatum</i> | Varagu |
| | | <i>Saccharum arundinaceum</i> | Nanal |
| | | <i>Saccharum officinarum</i> | Karumpu |
| 18 | Polygonaceae | <i>Polygonum glabrum</i> | Sivappu Kumbakodaali |
| 19 | Ponterderiaceae | <i>Eichhornia crassipes</i> | Agaya thamarai |
| 20 | Portulacaceae | <i>Portulaca oleracea</i> | Siru pasalai |
| 21 | Solanaceae | <i>Lycopersicon esculentum</i> | Thakkali |
| | | <i>Physalis minima</i> | Sodakku thakkali |
| | | <i>Solanum melongena</i> | kaththari |
| | | <i>Solanum trilobatum</i> | Thuthuvalai |
| | | <i>Solanum virginianum</i> | Kandankathiri |
| | | <i>Solanum xanthocarpum</i> | Sundai kai |
| 22 | Typhaceae | <i>Typha angustifolia</i> | Sambu |
| 23 | Zygophyllaceae | <i>Tribulus terrestris</i> | Nerunchi |

Climbers

133. The climbers were observed in the riverside and ponds/ tanks of the study area. Totally 9 climber species belonging to 7 families were noted from the study area **Table 34**. Some of the common species identified in the project area are *Ipomoea sp*, *Solanum trilobatum*, *Clitoria ternatea* and *Luffa acutangula*.

Table 34: List of climbers in the study area

| S.No | Family Name | Botanical Name | Vernacular name |
|------|----------------------|---------------------------|-----------------|
| 1 | Asclepidaceae | <i>Pergularia daemia</i> | Veliparuthi |
| 2 | Convolvulaceae | <i>Ipomoea aquatica</i> | vallai |
| | | <i>Ipomoea digitata</i> | Nilapoosani |
| | | <i>Ipomoea pes-caprae</i> | Aatukkal |
| 3 | <i>Cucurbitaceae</i> | <i>Citrullus lanatus</i> | peikumatti |
| 4 | Fabaceae | <i>Luffa acutangula</i> | Aagasaveni |
| 5 | Menispermaceae | <i>Clitoria ternatea</i> | Sangu poo |
| 6 | Polygonaceae | <i>Cocculus hirsutus</i> | Kattu kodi |
| 7 | Sapindaceae | <i>Antigonon leptopus</i> | Kodi rose |

134. **Fauna:** Faunal survey covers the Terrestrial Fauna, Avian Fauna and Aquatic Fauna. The survey was based on visual observation, Enquiry with local population and records available. This survey will include identification of endangered and rare species as per Red Book. Both direct and indirect observation methods were used to survey the fauna. Visual encounter (search) method was employed to record vertebrate species. Additionally survey

of relevant literature was also done to consolidate the list of vertebrate fauna distributed in the area (Smith 1933-43, Ali and Ripley 1983, Daniel 1983, Prater 1993, Murthy and Chandrasekhar 1988). Since birds may be considered as indicators for monitoring and understanding human impacts on ecological systems (Lawton, 1996).

135. Based on the Wildlife Protection Act, 1972 (WPA 1972, Anonymous 1991, Upadhyay 1995, Chaturvedi and Chaturvedi 1996) species were short-listed as Schedule II or I and where referred during the study. As per the study, there is no endangered / red list species in the study area.

136. **Birds:** The different species of birds are observed in the study area during the study period and they are given below and also enlisted in the **Table 35**. The common important birds species observed in the study area are *Acridotheres tristis*, *Alcedo atthis*, *Anas crecca*, *Ardea alba*, *Ardea cinerea*, *Bubo*, *Bubulcus ibis*, *Pycnonotus jocosus*, *Centropus sinensis*, *Cinnvris lotensis*, *Corvus corvus*, *Corvus splendens*, *Coryllis vaeralis*, *Dicrurus macrocerus*, *Egretta garzetta*, *Estrilda amanda va*, *Gallinula chloropus*, *Gallus gallus*, *Haliastur Indus*, *Hierococcyx varius*, *Coracias benghalensis*, *Lalage sykesi*, *Megalaima merulinus*, *Merops leschenaultia*, *Microfus affinis*, *Micropterus brachyurus*, *Muscicapa latirostris*, *Myctrea leucopcephala*, *Nectarinia asiatica*, *oriolus oriolus*, *Passer domesticus*, *Phalococorax carbo*, *Phalococorax Niger*, *Ploceus philppines*, *Podiceps yuficolis*, *Pycnonotus cafer* and *Temenuchus pagodarum*.

137. **Reptiles:** The common reptile's species that are observed in the study area were *Rana tigrina*, *Lepus nigricollis*, *Funabulus palmarum*, *Rattus norvegicus*, *Herpestes edwardii*, *Bandicota indica* and *Rana hexadactyla*.

Table 35: List of the faunal diversity of the study area

| Technical Name | Common Name | Distribution |
|------------------------------|----------------------------|--------------|
| <i>Acridotheres tristis</i> | Common myna | Common |
| <i>Alcedo atthis</i> | Common Kingfisher | Common |
| <i>Anas crecca</i> | Common teal | Observed |
| <i>Ardea alba</i> | Large egret | Common |
| <i>Ardea cinerea</i> | Grey heron | Common |
| <i>Bubo</i> | Indian great horned Owl | Common |
| <i>Bubulcus ibis</i> | Cattle Egret | Common |
| <i>Centropus sinensis</i> | Crow Pheasant | Common |
| <i>Cinnvris lotensis</i> | Loten's sunbird | Common |
| <i>Corvus corvus</i> | Jungle crow | Common |
| <i>Corvus splendens</i> | House crow | Common |
| <i>Coryllis vaeralis</i> | Lorikeet | Common |
| <i>Dicrurus macrocerus</i> | Black Drongo | Common |
| <i>Egretta garzetta</i> | Little Egret | Common |
| <i>Estrilda amanda va</i> | Red munia | Rare |
| <i>Gallinula chloropus</i> | Moor hen | Rare |
| <i>Gallus gallus</i> | Red Jungle fowl | Common |
| <i>Haliastur Indus</i> | Brahmny kite | Common |
| <i>Hierococcyx varius</i> | Common Hawk Cuckoo | Common |
| <i>Coracias benghalensis</i> | Indian roller | Common |
| <i>Lalage Sykesi</i> | Black headed cochoo Shrike | Common |
| <i>Megalaima merulinus</i> | Indian Cuckoo | Common |
| <i>Merops leschenaultia</i> | Chestnut headed Bee Eater | Common |
| <i>Microfus affinis</i> | House swift | Common |

| Technical Name | Common Name | Distribution |
|-------------------------------|----------------------|--------------|
| <i>Micropterus brachyurus</i> | Rufous Wood pecker | Observed |
| <i>Muscicapa latirostris</i> | Brown flycatcher | Rare |
| <i>Myctrea leucopcephala</i> | Painted stork | Common |
| <i>Nectarinia asiatica</i> | Purple sunbird | Observed |
| <i>oriolus oriolus</i> | Indian Oriole | Common |
| <i>Passer domesticus</i> | House Sparrow | Common |
| <i>Phalococorax carbo</i> | Large coramant | Common |
| <i>Phalococorax nicer</i> | Little coramant | Common |
| <i>Ploceus phillppines</i> | Weaver bird | Common |
| <i>Podiceps yuficolis</i> | Little grebe | Observed |
| <i>Pycnonotus cafer</i> | Red vented bulbul | Common |
| <i>pycnonotus jokonus</i> | White brewed Bulbul | Common |
| <i>Temenuchus pagodarum</i> | Brahmny Myna | Common |
| <i>calotes versicolor</i> | Common garden lizard | Rare |
| <i>Bangarus spp</i> | Krait | Rare |
| <i>Naja Naja</i> | Indian cobra | Rare |
| <i>Rana hexadactyla</i> | Frog | Common |
| <i>Rana tigrina</i> | Bull frog | Common |
| <i>Lepus nigricollis</i> | Hare | Herbivorous |
| <i>Funabulus palmarum</i> | Squirrel | Herbivorous |
| <i>Rattus norvegicus</i> | Field mouse | Herbivorous |
| <i>Herpestes edwardii</i> | Common mongoose | Carnivorous |
| <i>Bandicota indica</i> | Bandicoot | Herbivorous |

Source: Divisional Forest Officer

138. **Aquatic Fauna (Phytoplankton).** Water samples were collected from Mullaiperiyar Dam and it was centrifuged to concentrate the plankton organisms. Each sample was made up to 100 ml after removing from the centrifuge tube. General phytoplanktons were studied for quantitative and qualitative details. To assess the species diversity and the seasonal dynamics of different species of phytoplankton in the Mullaiperiyar Dam, all the different genera were identified and they were counted individually. Phytoplankton identified in the Mullaiperiyar Dam belongs to four classes namely *Cyanophyceae*, *Euglenophyceae*, *Bacillariophyceae* and *Chlorophyceae*. Average seasonal density of phytoplankton varied from 250 cells (southwest monsoon) to 496 cells (pre-monsoon). In general higher phytoplankton density was much more pronounced during the pre-monsoon than the monsoon periods in the Mullaiperiyar Dam.

D. Socio-economic Environment

i. Demography.

139. Total population of the Madurai Municipal Corporation is 18,46,801 as per 2011 census. The detail of population is given in the **Table 36**.

Table 36: Details Considered (As Per 2011 Census)

| Description | Nos. |
|----------------------------|-----------|
| Total Population | 18,46,801 |
| In the age group 0-6 years | 1,85,526 |
| Scheduled Castes (SC) | 1,51,124 |
| Scheduled Tribes (ST) | 6,230 |
| Literates | 14,85,340 |
| Illiterate | 3,61,461 |

| Description | Nos. |
|----------------------|-----------|
| Total Worker | 7,28,895 |
| Main Worker | 6,62,665 |
| Marginal Worker | 64,230 |
| Non Worker | 11,19,906 |
| Number of Households | 4,79,851 |

Source: Census 2011

j. Sex Ratio

140. The sex ratio of 999 females per 1,000 males is higher than the national average of 944. Madurai metropolitan area constitutes the third largest metropolitan area in Tamil Nadu and the 24th in India. 8.99 per cent of the population was under six years of age.

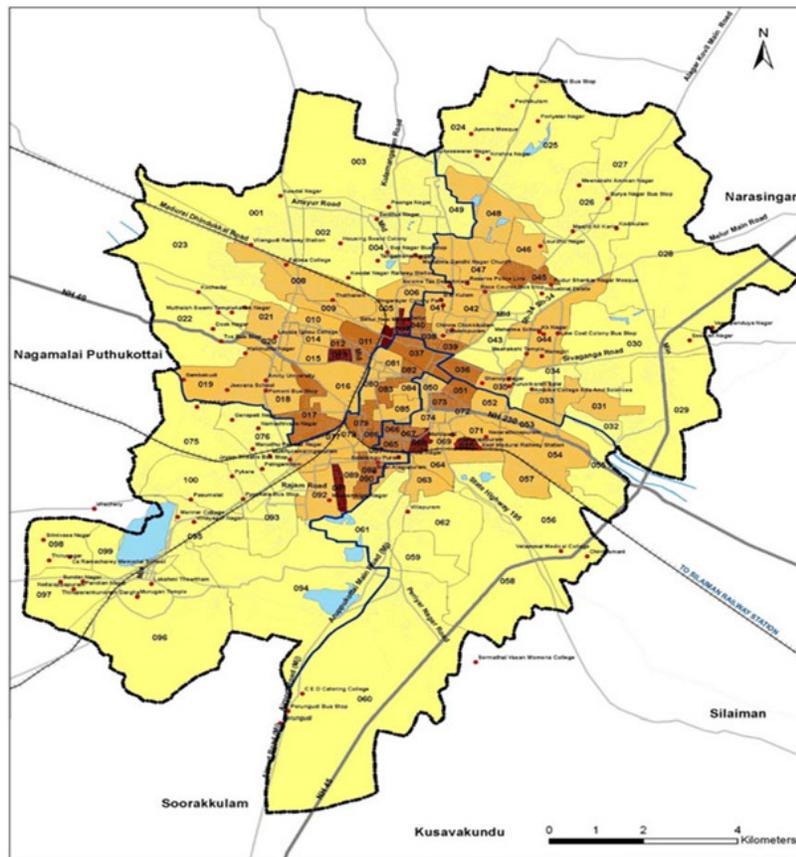


Figure 18: Resources profile of the Madurai city

k. Work Force Participation

141. The details of work force participation is given in the **Table 37**.

- Madurai ranks 9th with respect to the share in State GDP having 3.67% contribution to the total state GDP.
- Major economic activities are trade & commerce, tourism related activities and to some extent industrial activities.
- The city houses various health care facilities, automobile, rubber, chemical, and textile manufacturing industries and has also developed as a second tier city for information technology as well.

- Increasing trend of tertiary sector with involvement of 87% population indicating major role of tourism and trade.
- The secondary sector comprising majorly the household handloom industry has declined from 4.06% in 2001 to 3.61% in 2011.
- The Work Force Participation Rate is 39% showing an increase over the past decade.
- Share of marginal workers has grown from 4.31% in 2001 to 7.49% in 2011 indicating the high percentage of daily wages workers coming from adjacent areas to the city.

Table 37: Details of work force participation rate

| Details | Number | Growth % |
|-------------------------|-----------|----------|
| Primary sector | 8,683 | 2% |
| Secondary sector | 20,614 | 4% |
| Tertiary sector | 499,264 | 94% |
| Total main worker | 528,561 | 36% |
| Marginal worker | 42,767 | 3% |
| Total non-worker | 899,427 | 61% |
| Total population | 1,470,755 | |
| Work participation rate | 36% | |

I. Housing Scenario

142. The details of house stocks are given in **Table 38** and the quality of housing are given in **Table 39**.

- Present housing stock is adequate with 80% houses under residential use and 20% under mixed area.
- The growth in housing stock during the period of 2001-2011 was 27%.
- There is considerable increase in number of liveable (67%) and dilapidated houses (34%) in the city.

Table 38: Details of Housing Stock

| Parameters | 2001 | 2011 | Growth (%) |
|-------------------------------|--------|--------|------------|
| Total Census Houses | 240666 | 329775 | 27 |
| Vacant Houses | 10516 | 16776 | 37 |
| Occupied Houses | 230150 | 312999 | 26 |
| Residential Use | 194552 | 262163 | 26 |
| Residential Cum Other Purpose | 35598 | 50836 | 30 |

Table 39: Quality of Housing

| Parameters | 2001 | 2011 | Growth (%) |
|-------------|--------|--------|------------|
| Good | 185986 | 223042 | 17 |
| Livable | 13122 | 40904 | 68 |
| Dilapidated | 982 | 312999 | 39 |
| | 200090 | 265561 | 25 |

m. Infrastructure

143. **Transport and Traffic** Road development, public transport services and suburban rail transport are recognized as essential for the efficient functioning of the urban system. The major arterial & sub-arterial road corridors and other roads are developed and maintained by National Highway, State Highway and the local bodies concerned respectively. As regards traffic management and enforcement, the same is looked after by the City Traffic

Police in respect of Greater City Area and District Police for the remaining City Area. The public bus transport is with State Transport Corporation.

n. Education

144. There are 47 approved institutions of the university in and around the city consisting of autonomous colleges, aided colleges, self-financing colleges, constituent colleges, evening colleges and other approved institutions. There are seven polytechnics and five Industrial training institutes (ITIs) in Madurai, with the Government ITI and the Government Polytechnic for Women

o. Water Supply

145. Water Supply Department is taking care of planning and formulating water supply schemes, execution of scheme works and maintenance of water supply. Functions such as provision of new water service connection, conversion of category of service connection, name change, clearing of blocks in water supply. Redressal of other grievances are also carried out by Madurai Municipal Corporation.

p. Industries

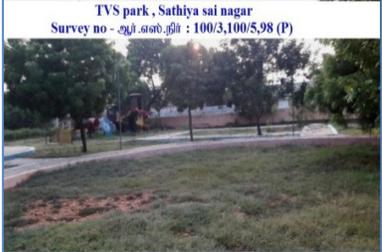
Madurai is one of the few rubber growing areas in South India, and there are rubberbased industries in Madurai. Automobile manufacturers are the major consumers of rubber components produced in the city. There are numerous textile, granite and chemical industries operating in Madurai. Madurai is promoted as a second-tier city for IT and some software companies have opened their offices in Madurai. Software Technology Parks of India, an agency of the Government of India, has authorised several such companies to receive benefits under its national information technology development program. The state government proposed two IT-based Special Economic Zones (SEZ) in Madurai, and these have been fully occupied by various IT companies.

Table 40: Subproject site Environmental Features:

| S.No | Infrastructure | Location and Environmental Features | Site Photograph |
|------|--|---|---|
| 1. | Sengol Nagar, Vilangudi | An overhead tank having a holding capacity of 10 lakhs litre will be constructed in an area at 400 sq.mt in the burial ground at ward No.23 Senkol nagar vilangudi. It will be located in Southwest direction of burialground.Compound wall will be constructed around the OHT. |  |
| 2. | Sellur Kanmai – Composting yard Sector 6 | An overhead tank having a holding capacity of 25 lakhs litre will be constructed in an Old composting yard in sector 6 at ward No.2 Sellur Kanmai having an area of 900 sq.mt. It will be located in Southwest direction; compound wall will be constructed around the OHT. |  |

| S.No | Infrastructure | Location and Environmental Features | Site Photograph |
|------|---|--|---|
| 3. | Sellur Lorry Stand | An overhead tank having a holding capacity of 15 lakhs litre will be constructed in Madurai Municipal Corporation, Southside of Sellur Lorry Stand at ward No.37 having area at 529 sq.mt. . Compound wall will be constructed around the OHT. |  |
| 4. | Kattabomman Street (Sivagami Street) | An overhead tank having a holding capacity of 15 lakhs litrewill be constructed in Madurai Municipal Corporation Kattabomman street, at ward No.41 (vacant land inside the corporation school) having area at 529 sq.mt. It will be located in Northeast direction compound wall will be constructed around the OHT. |  |
| 5. | Rajaji Park | An overhead tank having a holding capacity of 15 lakhs litre will be constructed in Madurai Municipal Corporation Rajaji Children's Park, at ward No.43 (vacant land behind Office) having an area of 529 sq.mt. The OHT will be located in Southwest provided with compound wall |  |
| 6. | SMP Colony near Mayor Bungalow (MPS site) | An overhead tank having a holding capacity of 15 lakhs litre will be constructed in Madurai Municipal Corporation, SMP colony at ward No.33 (vacant land near to Mayer Bungalow) having an area at 529 sq.mt. The OHT will be located in Southwest direction, provided with a compound wall. |  |
| 7. | KK Nagar (Central Veg. Market) | An overhead tank having a holding capacity of 5 lakhs litre will be constructed in Madurai Municipal Corporation, KK nagar Mellur main road, at ward No.45 (in the vacant land available in Mattuthavani Vegetable Market) having an area of 196 sq.mt. The OHT will be located in Southeast direction, provided with compound wall. |  |

| S.No | Infrastructure | Location and Environmental Features | Site Photograph |
|------|--|--|---|
| 8. | Zamburopuram market (Valavanthan Park) | An overhead tank having a holding capacity of 15 lakhs litre will be constructed in a vacant land in ward No.19 (Corporation park) having an area of 529 sq.mt. |  |
| 9. | Surveyor Colony (Anandaraj Nagar) | An overhead tank having a holding capacity of 15 lakhs litre will be constructed in the vacant land at ward No.27 having an area of 529 sqmt. The OHT will be located in Northeast direction, provided with a compound wall. |  |
| 10 | Arappalayam Two wheeler Parking | An overhead tank having a holding capacity of 25 lakhs litre will be constructed in a vacant land available in the ward No.10 (behind Arapalayam Two wheeler stand) having an area of 900 sqmt. The OHT will be located in Northwest direction, provided witha compound wall |  |
| 11 | Arasaradi back side of Pumping station | An overhead tank having a holding capacity of 25 lakhs litre will be constructed in the vacant land available at Arasaradi backside of the existing pumping stationat ward No.15 having an area of 900 sq.mt. The OHT will be located in Northeast direction, provided with compound wall. |  |
| 12 | VKP Nagar Madakulam | An overhead tank having a holding capacity of 20 lakhs litre will be constructed in Madurai Municipal Corporation, Madakkulam VKP nagar at ward No.76 having area at 729 sq.mt. The OHT will be located in Southern direction, provided with compound wall. |  |

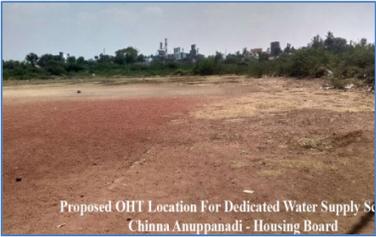
| S.No | Infrastructure | Location and Environmental Features | Site Photograph |
|------|---------------------------------------|---|---|
| 13 | Kochadai back side of Pumping station | An overhead tank having a holding capacity of 20 lakhs litre will be constructed in Madurai Municipal Corporation at ward No.22 (vacant land near Commissioner Bungalow Kochadai) having an area of 729 sq.mt. The OHT will be located in Northwest direction, provided with a compound wall. |  |
| 14 | TVS Park Sathya sai Nagar | An overhead tank having a holding capacity of 25 lakhs litre will be constructed in Madurai Municipal Corporation Satheyasai nagar, at ward No.77 (Vacant land available in Sundarajapuram Park) having an area at 900 sq.mt. The OHT will be located in Eastern direction, provided with a compound wall |  |
| 15 | TVS Park Sathya sai Nagar | An overhead tank having a holding capacity of 20 lakhs litewill be constructed in Madurai Municipal Corporation (TVS Park) Sathyasai nagar at ward No.92 having an area at 729 sq.mt. The OHT will be located in Southern direction, provided with compound wall. |  |
| 16 | Muthupatti Nagar near PS | An overhead tank having a holding capacity of 20 lakhs litre will be constructed in Madurai Municipal Corporation, Muthupatti nagar at ward No.93 (Vacant land near Pumping Station) having an area of 729 sq.mt. The OHT will be located in Northeast direction, provided with a compound wall. |  |
| 17 | Thideer Nagar | An overhead tank having a holding capacity of 20 lakhs litre will be constructed in Madurai Municipal Corporation (vacant land available near to fire station)) having an area at 729 sq.mt. |  |

| S.No | Infrastructure | Location and Environmental Features | Site Photograph |
|------|--|--|---|
| 18 | Thideer Nagar | An overhead tank having a holding capacity of 20 lakhs litre will be constructed in Madurai Municipal Corporation (vacant land available near to fire station)) having an area at 729 sq.mt. |  |
| 19 | Vaalaithoppu Corporation Ground | An overhead tank having a holding capacity of 25 lakhs litre will be constructed in Madurai Municipal Corporation, Vaalaithoppu (towards Chinthamani main road from Kamarajar salai) at ward No.64 (vacant land) having an area of 900 sqmt. The OHT will be located in centre, provided with, compound wall |  |
| 20 | AVSS Hospital behind MPS Santhaipettai | An overhead tank having a holding capacity of 25lakhs litre will be constructed in Madurai Municipal Corporation, Santhaipettai, at ward No.53 (Vacant land available at backside of main pumping station) having area of 900 sq.mt. It will be located in eastern direction, provided with compound wall. |  |
| 21 | Meenakshi Nagar | An overhead tank having a holding capacity of 20lakhs litewill be constructed in Madurai Municipal Corporation, at ward No.54 (vacant land available in Meenakshi Nagar near to Theppakulam Kamaraj Statue) having an area of 729 sqmt. The OHT will be located in eastern direction, provided with compound wall. |  |
| 22 | Slaughter House | An overhead tank having a capacity of 15 lakhs litre will be constructed in house vacant land of Madurai Corporation Anupanadi Slaughter house at ward No.57 Anupanadi having an area of 529 sqmt. It will be located in Northwest, compound wall will be constructed around the OHT. |  |

| S.No | Infrastructure | Location and Environmental Features | Site Photograph |
|------|---------------------------------------|---|---|
| 23 | Muniyandi Kovil street (Ward 100,75) | An overhead tank having a capacity of 2 lakhs litre will be constructed in Madurai Corporation Muniyandi kovil street, Muniyandi kovil backside at ward No.75 & 100 Muniyandi kovil having an area of 81 sqmt. It will be located in Southwest, compound wall will be constructed around the OHT. |  |
| 24 | Muthuramalinga Puram Bykara(ward 100) | An overhead tank having a capacity of 5 lakhs litre will be constructed in Madurai Corporation Muthuramalingapuram near to Existing OHT land at ward No.100 Muthuramalingapuram, Bykara having an area of 196 sqmt. It will be located in Centre, compound wall will be constructed around the OHT. |  |
| 25 | Semparuthi Nagar –NZ1 | An overhead tank having a capacity of 15 lakhs litre will be constructed in Madurai Corporation Vilangudi, Semparuthi nagar park vacant land at ward No.23 Vilangudi having an area of 400 sqmt. It will be located in West; compound wall will be constructed around the OHT. |  |
| 26 | Mudakkathan – N24 | An overhead tank having a capacity of 10 lakhs litre will be constructed in Madurai Corporation Mudakkathan Playground opposite to Alangulam kanmai land at ward No.4 Sunday market having an area of 400 sqmt. It will be located in Southeast, compound wall will be constructed around the OHT. |  |
| 27 | Alangkulam Lake –N24A | An overhead tank having a capacity of 10 lakhs litre will be constructed in Madurai Corporation Alangulam kanmai near the existing OHT land at ward No.4 Alangulam kanmai having an area of 400 sqmt. It will be located in West; compound wall will be constructed around the OHT. |  |

| S.No | Infrastructure | Location and Environmental Features | Site Photograph |
|------|-----------------------------------|---|---|
| 28 | Anaiyur – NZ3 | An overhead tank having a capacity of 10 lakhs litre will be constructed in Madurai Corporation near to Anaiyur, Silayaneri burial groundvacant land at ward No.3 Sunday market having an area of 400 sqmt. It will be located in Southeast, compound wall will be constructed around the OHT. |  |
| 29 | Indranagar – NZ2 | An overhead tank having a capacity of 10 lakhs litre will be constructed in Madurai Corporation Indiranagar, Karisalkulam 2 nd railway gate crossing vacant land at ward No.1 Karisalkulam having area at 400 sqmt. It will be located in Northwest, compound wall will be constructed around the OHT. |  |
| 30 | Park Town – NZ5 | An overhead tank having capacity of 10 lakhs liter will be constructed in Madurai Corporation Meenakshi nagar, Thapalthanthi nagar NGO colony park, Park Town vacant land at ward No.4 Park Town having area at 400 sqmt. It will be located in South; compound wall will be constructed around the OHT. |  |
| 31 | Thiruppalai – NZ7A (Chakra Nagar) | An overhead tank having capacity of 5 lakhs liter will be constructed in Madurai Corporation Thirupalai Pasumpon nagar burial groundvacant land at ward No.24 Thirupalai having area at 196 sqmt. It will be located in North; compound wall will be constructed around the OHT. |  |
| 32 | EB Colony – NZ7 | An overhead tank having capacity of 10 lakhs liter will be constructed in Madurai Corporation EB colony vacant land at ward No.25 EB colony having area at 400 sqmt. It will be located in Northeast; compound wall will be constructed around the OHT. |  |
| 33 | Naganakulam – | An overhead tank having |  |

| S.No | Infrastructure | Location and Environmental Features | Site Photograph |
|------|--------------------------------|---|---|
| | NZ6(Ward – 49) | capacity of 10 lakhs liter will be constructed in Madurai Corporation Naganakulam adjacent of kanmai left side of Naganakulam kanmai to Natham main road vacant land at ward No.49 Naganakulam having area at 400 sqmt. It will be located in East; compound wall will be constructed around the OHT. | |
| 34 | Bharath Nagar | An overhead tank having capacity of 10 lakhs liter will be constructed in Madurai Corporation Bharathnagar, vacant land at ward No.23 having area at 400 sqmt. It will be located in South; compound wall will be constructed around the OHT. |  |
| 35 | Island Nagar – NZ8 (Ward – 48) | An overhead tank having capacity of 10 lakhs liter will be constructed in Madurai Corporation Island nagar near to pond vacant land at ward No.48 Island nagar having area at 400 sqmt. It will be located in West; compound wall will be constructed around the OHT. |  |
| 36 | GR Nagar – NZ9 | An overhead tank having capacity of 10 lakhs liter will be constructed in Madurai Corporation GR nagar park vacant land at ward No.25 GR nagar having area at 400 sqmt. It will be located in Northeast; compound wall will be constructed around the OHT. |  |
| 37 | PoriyalarNagar | An overhead tank having capacity of 5 lakhs liter will be constructed in Madurai Corporation Pandian nagar – Engineer nagar park vacant land at ward No.24 Pandian nagar – Engineer nagar having area at 196 sqmt. It will be located in South, compound wall will be constructed around the OHT. |  |

| S.No | Infrastructure | Location and Environmental Features | Site Photograph |
|------|--------------------------------------|--|---|
| 38 | Shenpagathottam – NZ 14 | An overhead tank having capacity of 15 lakhs liter will be constructed in Madurai Corporation Shenpagathottam park near to Anna nagar channel vacant land at ward No.33 Shenpagathottam having area at 529 sqmt. It will be located in Southwest, compound wall will be constructed around the OHT. |  |
| 39 | Shenpagathottam – NZ15 | An overhead tank having capacity of 15 lakhs liter will be constructed in Madurai Corporation Shenpagathottam park-2 near to Anna nagar channel vacant land at ward No.33 Shenpagathottam having area at 529 sqmt. It will be located in Northeast; compound wall will be constructed around the OHT. |  |
| 40 | Iravathanallur – SZ1 | An overhead tank having capacity of 5 lakhs liter will be constructed in Madurai Corporation Iravathanallu burial ground near to Iravathanllur check post vacant land at ward No.55 Iravathanallur burial ground having area at 196 sqmt. It will be located in South; compound wall will be constructed around the OHT. |  |
| 41 | Chinna Anuppanadi –SZ2 | An overhead tank having capacity of 10 lakhs liter will be constructed in Madurai Corporation Chinna anupanadi school playground vacant land at ward No.56 Chinna Anuppanadi having area at 400 sqmt. It will be located in West; compound wall will be constructed around the OHT. |  |
| 42 | Gurunathar Koil – SZ3 (Chinnthamani) | An overhead tank having capacity of 10 lakhs liter will be constructed in Madurai Corporation Chinthamani near to Gurunathan kovil land at ward No.58 Iravathanallur burial ground having area at 400 sqmt. It will be located in East; compound wall will be constructed around the OHT. |  |

| S.No | Infrastructure | Location and Environmental Features | Site Photograph |
|------|------------------------------|--|---|
| 43 | MMC Colony – SZ 5 | An overhead tank having capacity of 10 lakhs liter will be constructed in Madurai Corporation Avaniyapuram MMC colony vacant land at ward No.94 MMC colony having area at 400 sqmt. It will be located in East; compound wall will be constructed around the OHT. |  |
| 44 | MMC Colony – SZ4 | An overhead tank having capacity of 10 lakhs liter will be constructed in Madurai Corporation Avaniyapuram MMC colony vacant land at ward No.94 MMC colony having area at 400 sqmt. It will be located in West; compound wall will be constructed around the OHT. |  |
| 45 | Villapuram – SZ6 (Ward – 61) | An overhead tank having capacity of 10 lakhs liter will be constructed in Madurai Corporation Villapuram existing OHT vacant land at ward No.61 Villapuram OHT having area at 400 sqmt. It will be located in Southwest, compound wall will be constructed around the OHT. |  |
| 46 | Sempoorani – SZ7 | An overhead tank having capacity of 10 lakhs liter will be constructed in Madurai Corporation Avaniyapuram near to Periyar statue existing OHT vacant land at ward No.94 Avaniyapuram having area at 400 sqmt. It will be located in East; compound wall will be constructed around the OHT. |  |
| 47 | Vellakkal – SZ8 | An overhead tank having capacity of 15 lakhs liter will be constructed at opposite side of Vellakkal Corporation bungalow vacant land at ward No.94 Vellakkal having area at 529 sqmt. It will be located in East; compound wall will be constructed around the OHT. |  |

| S.No | Infrastructure | Location and Environmental Features | Site Photograph |
|------|------------------------------------|---|---|
| 48 | Harvipatti – SZ10 | An overhead tank having capacity of 10 lakhs liter will be constructed in Madurai Corporation Harveypatti park vacant land at ward No.98 Harveypatti having area at 400 sqmt. It will be located in South; compound wall will be constructed around the OHT. |  |
| 49 | Kurinchi Nagar – SZ11 (Thirunagar) | An overhead tank having capacity of 5 lakhs liter will be constructed in Madurai Corporation Thirunagar Kurinchinagar, Utchayamedu vacant land at ward No.98 Kurinchi nagar having area at 196 sqmt. It will be located in Northeast; compound wall will be constructed around the OHT. |  |
| 50 | Balaji Nagar – SZ12 | An overhead tank having capacity of 5 lakhs liter will be constructed in Madurai Corporation thiruparankudram vacant land at ward No.99 Thiruparankundram having area at 196 sqmt. It will be located in Right side of the park; compound wall will be constructed around the OHT. |  |
| 51 | Moolakarai Sump – SZ9 | An overhead tank having capacity of 2 lakhs liter will be constructed in Madurai Corporation Moolakarai sump vacant land at ward No.99 Moolakarai sump having area at 81 sqmt. It will be located in North; compound wall will be constructed around the OHT. |  |
| 52 | Pasumalai – SZ13 | An overhead tank having capacity of 5 lakhs liter will be constructed in Madurai Corporation Pasumalai burial ground vacant land at ward No.99 Kurinchi nagar having area at 196 sqmt. Compound wall will be constructed around the OHT. |  |

| S.No | Infrastructure | Location and Environmental Features | Site Photograph |
|------|----------------------------------|--|---|
| 53 | Ulaganeri – NZ 11 (Ward – 28) | An overhead tank having capacity of 10 lakhs liter will be constructed in Madurai Corporation Ulaganeri near to High court street existing OHT vacant land at ward No.28 Ulaganeri having area at 400 sqmt. It will be located in West; compound wall will be constructed around the OHT. |  |
| 54 | Pandian Nagar – NZ12 | An overhead tank having capacity of 10 lakhs liter will be constructed in Madurai Corporation Pandiyan nagar near to Pandi kovil police station vacant land at ward No.31 Pandiyan nagar having area at 400 sqmt. It will be located in Southwest, compound wall will be constructed around the OHT. |  |
| 55 | Pandian Nagar – NZ 13 | An overhead tank having capacity of 15 lakhs liter will be constructed in Madurai Corporation Pandiyan nagar near to Pandi kovil police station vacant land at ward No.31 Pandiyan nagar having area at 529 sqmt. It will be located in Southeast, compound wall will be constructed around the OHT. |  |
| 56 | Kadachanendhal - Ward 26 | An overhead tank having capacity of 2 lakhs liter will be constructed in Madurai Corporation Kadachanendhal vacant land at ward No.26 Kadachanenthal having area at 81 sqmt. It will be located in Southwest, compound wall will be constructed around the OHT. |  |

146. The distribution main, feeder main and conveying main will be laid along the edge of the streets and roads without affecting the existing infrastructures. Before commencing the pipe laying work, necessary road cut restoration charges will be paid to the concerned Department and permission will be obtained to cut open the road. On completion of the pipe laying work, the roads will be properly filled and consolidated with excavated earth and intimated to the Department concerned. The National highways authority and State highways authority will carry out the restoration of road.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

147. Potential environmental impacts of the proposed infrastructure components are presented in this section. Mitigation measures to minimize/mitigate negative impacts, if any, are recommended along with the agency responsible for implementation. Monitoring actions to be conducted during the implementation phase is also recommended to reduce the impact.

148. Screening of potential environmental impacts are categorized into four categories considering subproject phases: location impacts and design impacts (pre-construction phase), construction phase impacts and operations and maintenance phase impacts.

- (i) **Location impacts** include impacts associated with site selection and include loss of on-site biophysical array and encroachment either directly or indirectly on adjacent environments. It also includes impacts on people who will lose their livelihood or any other structures by the development of that site.
- (ii) **Design impacts** include impacts arising from Investment Program design, including technology used, scale of operation/throughput, waste production, and ancillary services.
- (iii) **Construction impacts** include impacts caused by site clearing, earthworks, machinery, vehicles and workers. Construction site impacts include erosion, dust, noise, traffic congestion and waste production.
- (iv) **O & M impacts** include impacts arising from the operation and maintenance activities of the infrastructure facility. These include routine management of operational waste streams, and occupational health and safety issues.

149. Screening of environmental impacts has been based on the impact magnitude (negligible/moderate/severe – in the order of increasing degree) and impact duration (temporary/permanent).

150. This section of the IEE reviews possible project-related impacts, in order to identify issues requiring further attention and screen out issues of no relevance. ADB SPS (2009) require that impacts and risks will be analyzed during pre-construction, construction, and operational stages in the context of the project's area of influence. The ADB Rapid Environmental Assessment Checklist in http://www.adb.org/documents/guidelines/environmental_assessment/eaguidelines002.asph as been used to screen the project for environmental impacts and to determine the scope of the IEE.

151. In the case of this project (i) Most of the individual elements involve simple construction and operation. By using the gravity based system impacts will be minimum (ii) Most of the predicted impacts are associated with the construction process, and are produced because that process is invasive, involving excavation and earth movements and (iii) Being mostly located on the roadside (SH, NH, ODR and rural roads) so will not cause direct impact on biodiversity values. The project will be located in the properties held by the local government and access to the project location is through public rights-of-way and existing roads. The head works site is the only land need to be procured for an extent of 2 acres, for which consent from the owner of the land has been obtained. Land acquisition is in process, and is with Revenue Department with private owner now negotiation. The details of the land acquisition is covered under RP.

A. Pre-Construction Impacts- Design and Location

152. **Design of the Proposed Components.** The Central Public Health and Environment Engineering Organization (CPHEEO) manual suggests a design period of 15/30 years. The water supply components were designed following the recommendations of the CPHEEO Manual for Water Supply and Treatment.

153. Impacts arise from the design of the project including the technology used, scale of operation, waste production, discharge specification, pollution sources and ancillary services.

154. Impacts associated with the planning mainly depend on the site selection. Location impacts include on-site biophysical array and encroachment / impact either directly or indirectly on adjacent environments. It also includes the impacts on the people who might lose their properties or livelihoods due to the development of the proposed site.

155. Construction works in the Madurai Corporation area, the pipelines are to be laid on or along the roads in the unused vacant land adjacent to the roads within the project area. In the narrow roads (where there is no vacant land adjoining road), pipeline will be buried within the road right of way. However, considering the narrow and busy lanes, temporary impacts are likely during construction stage.

156. **Site selection of sources of materials.** Extraction of materials can disrupt natural land contours and vegetation resulting in accelerated erosion, disturbance in natural drainage patterns, ponding and water logging, and water pollution. To mitigate the potential environmental impacts, locations of quarry site/s and borrow pit/s (for loose material other than stones) would be included in the design specifications and on plan drawings. Priority would be sites already permitted by Mining Department. If other sites are necessary, these would to be located away from population centers, drinking water intakes and streams, cultivable lands, and natural drainage systems; and in structurally stable areas even if some distance from construction activities. It will be the construction contractor's responsibility to verify the suitability of all material sources and to obtain the approval of the PIU (Madurai Municipal Corporation). If additional quarries will be required after construction is started, then the Construction Contractor shall use the mentioned criteria to select new quarry sites, with written approval of Madurai Municipal Corporation.

B. Construction Impacts

157. **Impact on Air Quality:** During construction period, the impacts on air quality are mainly due to the material movement and the actual construction activities. Due to material movement air, quality over the immediate influence area will be affected though, not in significant levels. There will be increase in the dust levels. In order to reduce the dust emissions in the construction area due to material transport and construction activities, provisions should be made for sprinkling of water on all the roads in the area of improvement. It should be ensured that

- Construction debris is removed daily
- Construction requiring street closings should be performed during off-peak hours.
- Idling of delivery trucks or other equipment should not be permitted during periods of unloading or when they are not in active use
- Low emission construction vehicles should be used wherever possible
- As soon as construction is over the surplus earth should be utilised to fill up low-lying areas. In no case, loose earth should be allowed to pile up in the streets.

158. Anticipated impacts during the construction phase are discussed below along with appropriate mitigation measures to avoid, minimize or mitigate those impacts to acceptable levels.

159. **Sources of Materials.** For the construction work, the required materials like coarse aggregate and fine aggregate will be obtained from the permitted / licensed quarries by Department of Geology & Mining, Government of Tamil nadu. Contractor should not create/use any new borrow pits / quarries. The contractor should also make a concerted effort to re-use as much excavated material from this project as possible.

160. The construction contractor will be required to:

- (i) Obtain construction materials only from government-approved quarries with prior approval from Madurai Corporation.
- (ii) Madurai Municipal Corporation to review, and ensure that proposed quarry sources have all necessary clearances/ permissions in place prior to approval
- (iii) Contractor to submit to Madurai Corporation on a monthly basis documentation on material obtained from each sources (quarry/ borrow pit)
- (iv) Avoid creation of new borrow areas, quarries etc., for the project; if unavoidable, contractor to obtain all clearances and permissions as required under law, including Environmental Clearance (EC) prior to approval by Madurai Corporation.

161. **Air Pollution during Construction work**, especially from earthwork activities, coupled with dry and windy working conditions, material and debris transport, and works along the public roads carrying significant traffic, have high potential to generate dust. Significant quantities of earthwork will be conducted in the subproject, spread all over the project area. Nearly 10,00,000 m³ of earthwork is anticipated from the subproject, and 90-95% of which will be reused for filling the trenches. Also emissions from construction vehicles, equipment, and machinery used for excavation and construction will induce impacts on the air quality. Anticipated impacts include dust and increase in concentration of vehicle-related pollutants such as carbon monoxide, sulfur oxides, particulate matter, nitrous oxides, and hydrocarbons. Dust generation from construction work in individual and confined work sites for UGT, OHT etc., will be mainly during the initial construction phase of earthwork, as the site is confined, dust can be effectively controlled with common measures. Dust generation will be significant during pipe laying along the roads. Increase in dust/ particulate matter in ambient air is detrimental, and may have adverse impacts on people and environment. To mitigate the impacts, construction contractors will be required to:

For all construction works

- (i) Damp down the soil and any stockpiled material on site by water sprinkling (3-4 times a day - before the start of work, 1-2 times in between, and at the end of the day) when working in the roads there should permanently be one person responsible for directing when water sprinkling needs to take place to stop the dust moving.
- (ii) Reduce the need to sprinkle water by stabilizing surface soils where loaders, support equipment and vehicles will operate by using water and maintain surface soils in a stabilized condition.
- (iii) Apply water prior to levelling or any other earth moving activity to keep the soil moist throughout the process.
- (iv) Cover the soil stocked at the sites with tarpaulins and surround by dust screens.
- (v) Control access to work area, prevent unnecessary movement of vehicle, public trespassing into work areas; limiting soil disturbance will minimize dust generation.

- (vi) Use tarpaulins to cover the loose material (soil, sand, aggregate etc..) when transported by open trucks.
- (vii) Control dust generation while unloading the loose material (particularly aggregate, sand, soil) at the site by sprinkling water and unloading inside the barricaded area, minimize the drop height when moving the excavated soil.
- (viii) Clean wheels and undercarriage of haul trucks prior to leaving construction site.
- (ix) Ensure that all the construction equipment, machinery are fitted with pollution control devices, which are operating correctly, and have a valid pollution under control (PUC) certificate.
- (x) No vehicles or plant to be left idling at site generators to be at placed maximum distance from properties.

For pipe laying works

- (i) Barricade the construction area using hard barricades (of 2 m height) on both sides
- (ii) Initiate site clearance and excavation work only after barricading of the site is done
- (iii) Confine all the material, excavated soil, debris, equipment, machinery (excavators, cranes etc..) to the barricaded area.
- (iv) Limit the stocking of excavated material at the site; remove the excess soil from the site immediately to the designated disposal area
- (v) Undertake the work section wise a 100 m section should be demarcated and barricaded; open up several such sections at a time, but care shall be taken to locate such sections in different zones
- (vi) Conduct work sequentially - excavation, pipe laying, backfilling; testing section-wise (for a minimum length as possible) so that backfilling, stabilization of soil can be done.
- (vii) Remove the excavated soil of first section to the disposal site; as the work progresses sequentially, by the time second section is excavated, the first section will be ready for back filling, use the freshly excavated soil for back filling, this will avoid stocking of material, and minimize the dust.
- (viii) Backfilled trench at any completed section after removal of barricading will be the main source of dust pollution. The traffic, pedestrian movement and wind will generate dust from backfilled section. Road restoration shall be undertaken immediately.

162. Excavation and refilling activities disturb the top soil, and under the influence of wind, traffic, pedestrians, and other activities etc., produces dust. There is large potential to generate significant quantities of dust after refilling the trench, and prior to road relaying. It is a common practice not to restore the road immediately after refilling the trench so as to allow sufficient time for the refilled material to stabilize naturally. Given the dry and windy conditions, and heavy traffic and other activities along the roads, the refilled trenches with loose top soil along the roads will generate maximum dust, and create very unhealthy conditions. Moreover, as the barricades/dust screens will removed after the trench is refilled, there will be absolutely nothing to control the dust generation. Dust control activities like wetting of top soil will not be effective given the site conditions. It is therefore necessary to restore/relay the road surface immediately or takesuitable steps to arrest the dust. Soil consolidation technique shall be used so that road can be restored immediately.

163. While obtaining permission for the proposed raw water transmission main from NH, SH & rural roads, the necessaryrestoration charges will be paid and accordingly the respective department will restore their roads.

164. **Generation of Construction Wastes:** Solid wastes generated from the construction activities are excess excavated earth (spoils), discarded construction materials, cement bags, wood, steel, oils, fuels and other similar items. Domestic solid wastes may also be generated from the workers' camp. Improper waste management could cause odor and vermin problems, pollution and flow obstruction of nearby watercourses and could negatively impact the landscape. Earthwork excavation in the road will be reused for leveling the roadside and earth excavation from other location will be safely disposed to corporation lands.

165. The following mitigation measures to minimize impacts from waste generation shall be implemented by the contractor:

- (i) Prepare and implement a Construction Waste (Spoils) Management Plan (format is given in **Appendix 4**)
- (ii) Avoid stockpiling any excess spoils at the site for long time. Excess excavated soils should be disposed to corporation lands.
- (iii) If disposal is required, the site shall be selected preferably from barren, infertile lands; sites should be located away from residential areas, forests, water bodies and any other sensitive land uses.
- (iv) Domestic solid wastes should be properly segregated in biodegradable and non-biodegradable for collection and disposal to designated solid waste disposal site; create a compost pit at workers camp sites for disposal of biodegradable waste; non-biodegradable / recyclable material shall be collected separately and sold in the local recycling material market
- (v) Prohibit burning of construction and/or domestic waste;
- (vi) Ensure that wastes are not haphazardly thrown in and around the study area; provide proper collection bins, and create awareness to use the dustbins; recycle waste material where possible.
- (vii) Conduct site clearance and restoration to original condition after the completion of construction work; PIU to ensure that site is properly restored prior to issuing of construction completion certificate.

166. **Surface Quality Impacts:** Madurai and surrounding region receives average rainfall and there are a number of natural and man-made drainage channels crossing the city to carry the runoff safely. Runoff from the excavated areas and material and waste soil stocks likely to contain silt, and this silt runoff will deteriorate the water bodies due to silting. Large-scale silting is likely to lead to flooding. This impact will however be considered only during rainy season. These potential impacts are temporary and are of short-term duration only and to ensure these are mitigated, construction contractor will be required to

- (i) Avoid stockpiling of earth fill especially during the monsoon season unless covered by tarpaulins or plastic sheets;
- (ii) Prioritize re-use of excess spoils and materials in the construction works. If spoils will be disposed, consult with Madurai city municipal corporation on designated disposal areas;
- (iii) Install temporary silt traps or sedimentation basins along the drainage leading to the water bodies;
- (iv) Place storage areas for fuels and lubricants away from any drainage leading to water bodies;
- (v) Dispose any wastes generated by construction activities in designated sites; and

- (vi) Conduct surface quality inspection according to the Environmental Management Plan(EMP).

167. **Aquatic Environmental Impacts:** The intake well is proposed on the banks of the Mullai Periyar River and hence it will not have a direct impact on the existing aquatic ecology of the river, Information obtained from the secondary sources reveals that there are no movement/ migration of fish species/ fish breeding ground or endangered fish species/ aquatic animals found in the River Mullai Periyar.Hence the proposed Intake well construction works will not have any impact on the fish species/ fish breeding pattern. However, care shall be taken to avoid deposition/ disposal of construction waste / accidental spillage of construction material in to the river and also construction works shall be restricted during the monsoon seasons.

168. **Water Treatment Plant:** The raw water source is not suitable for the drinking purpose, so the Water Treatment Plant is proposed to treat raw water to meet the drinking water standards before distribution. The proposed Water Treatment Plant will be constructed in 12.5-acre land at Pannaipatti Village. The treatment plant layout has to be planned to treat 125 MLD of raw water. The proposed WTP will be based on conventional treatment process involving coagulation, flocculation, sedimentation, filtration process, disinfectionetc.The construction of WTP is proposed under Design and Build basis as per the process specified to suit the available site.

169. To ensure optimal utilization and reduction of wastage, necessary design is incorporated in WTP to recycle the wash water. The backwash water (3% of capacity) from proposed WTP will be stored within the premises for further recirculation. For reuse and recirculation of the backwash water, proper recirculation system will be installed in the proposed WTP. From the recycled quantity, a maximum of 2.5% out of 3% and the balance 0.5% will be utilized for gardening and other uses inside the WTP site.Prior to discharge/reuse the backwash will be tested in the Laboratory proposed in the WTP site.

170. Sludge from the Water Treatment Plant is proposed to be dried in the sludge drying beds. The dried sludge will be stored in stockyard within the WTP premises and it will be disposed periodically or in the area identified by the Madurai Municipal Corporation at a maximum distance of 30 km from WTP. The drained water from sludge drying bed and supernatant water from sludge thickener will be sent into re-circulation sump.The sludge shall be taken to the sludge balance tank and from there discharge to nearby drain. The filtrate will be re-circulated to the raw water distribution chamber.

171. **Chlorine use in WTP.**There is invariably a safety risk when considerable quantities of chlorine are handled at the WTP. The per day consumption of chlorine is around 1 tonnes. Therefore, the yearly consumption is 365 tonnes at the WTP. The cylinders will be stored in a bay with individual foundations with trunnion wheels as support for easy handling. The cylinders are kept in horizontal positions on the trunnion wheels. An EOT crane with electrical motor is provided for safe handling to reduce the man usage, as it is a hazard gas. To avoid any risk to workers and public, the chlorination facility at the WTP will be provided with all appropriate safety features and equipment to meet with any accidental eventuality, which may include:

- (i) Chlorine neutralization pit with a lime slurry feeder;
- (ii) Proper ventilation, lighting, entry and exit facilities;
- (iii) Facility for isolation in the event of major chlorine leakage;

- (iv) Personal protection and safety equipment for the operators in the chlorine plant; The emergency repair kit, Personal safety kit like full body cover, Oxygen kit for breathing, face mask, body shower and eye washers would be provided
- (v) Laboratory facility shall not be housed within the chlorination facility;
- (vi) Provide training to the staff in safe handling and application of chlorine; this shall be included in the contract of Chlorinator supplier; and
- (vii) Visible and audible alarm facilities to alert chlorine gas leak;
- (viii) Supplier of Chlorinator equipment shall provide standard operating manual for safe operation and as well as maintenance and repairs; preferably these shall be provided both in English and Tamil Languages.
- (ix) If the chlorine storage will be within 100 m of any sensitive receptor, the project will involve them in the emergency response planning. In this project, nearest residential unit are located about 260 m from the proposed WTP plant. Therefore, the project will not involve them in the emergency response planning.

172. **Noise and Vibration Levels.** The water distribution station sites are located within habitations, where there are houses, schools and hospitals, religious places and businesses. During construction stage increase in noise level may be caused by excavation, particularly breaking of cement concrete or bitumen roads for the purpose of laying of pipe, operation of construction equipment, and the transportation of equipment, materials, and people. Vibration generated from construction activity, for instance from the use of pneumatic drills, will have impact on nearby buildings. The construction contractor will be required to:

- (i) Plan activities in consultation with PIU so that activities with the greatest potential to generate noise are conducted during periods of the day which will result in least disturbance; especially near schools and other sensitive receptors
- (ii) Minimize noise from construction equipment by using vehicle silencers, fitting jackhammers with noise-reducing mufflers, and use portable street barriers to minimise sound impact to surrounding sensitive receptor;
- (iii) Maintain maximum sound levels not exceeding 70 decibels (dBA) when measured at a distance of 10 m or more from the vehicle/s.
- (iv) Identify any buildings at risk from vibration damage and avoiding any use of pneumatic drills or heavy vehicles in the vicinity; if any building at risk, structural survey be completed prior to work, to provide baseline in case any issues from vibration, and if building is structurally unsound that measures taken to avoid any further damage
- (v) Horns should not be used unless it is necessary to warn road users or animals of the vehicle's approach;
- (vi) Consult local communities in advance of the work to identify and address key issues, and avoid working at sensitive times, such as religious and cultural festivals.

173. **Accessibility and Traffic Disruptions.** Madurai City Municipal Corporation is maintaining 1572.38 Km length of roads. 22.58 Km of Stone cut & Tiles paved roads.

Table 41: Details of the type of roads and its lengths

| Roads | Length in KM. |
|-----------------|----------------------|
| Bus Route Roads | 162.87 Km |
| Ring Road | 27.20 Km |
| Internal Road | 239.66 Km |

| Roads | Length in KM. |
|--------------|----------------------|
| Total | 532.22 Km |

| Sl. No. | Roads | Length in KM. |
|----------------|---------------------------------|----------------------|
| 1 | B.T. Roads | 947.94 |
| 2 | C.C. Road | 268.99 |
| 3 | Metal Roads | 125.50 |
| 4 | Sand Road | 207.52 |
| 5 | Stone cut & Tiles paved roads | 22.58 |
| | Total | 1572.38 |
| Sl. No | Road Category | Length (Km) |
| 1 | Municipal Roads | 661.81 |
| 2 | Highways & Major District Roads | 34.00 |
| | Total | 695.81 |

174. The mainroads in the Madurai City Municipal Corporation carries considerable traffic. These roads are also centers of commercial activities. Internal roads in the project area are narrow, except in the newly developing residential layout, which comparatively have wide roads. Pipes to be laid across some of the arterial roads. In other Corporation maintained busy roads, work will be taken up during non-traffic hours/ night hours without much hindrance to the free flow of traffic. Potential impact is negative but short term and reversible by mitigation measures. The construction contractor will be required to

- (i) Plan transportation routes so that heavy vehicles do not use narrow local roads, except in the immediate vicinity of delivery sites;
- (ii) Schedule transport and hauling activities during non-peak hours;
- (iii) Locate entry and exit points in areas where there is low potential for traffic congestion;
- (iv) Keep the site free from all unnecessary obstructions;
- (v) Drive vehicles in a considerate manner;
- (vi) Coordinate with City Traffic Office for temporary road diversions and necessary provision of traffic aids if transportation activities cannot be avoided during peak hours;
- (vii) Notify affected sensitive receptors by providing sign boards informing nature and duration of construction works and contact numbers for concerns/complaints.
- (viii) Provide planks across trenches in front of businesses, and ensure works are completed quickly to avoid disruption
- (ix) Avoid full street closure

175. **Surface and Groundwater Quality.** Another physical impact that is often associated with excavation is the effect on drainage and the local water table if groundwater and surface water collect in the voids. To ensure that water will not pond in pits and voids near subproject location, the construction contractor will be required to conduct excavation works on non- monsoon season.

176. **Accessibility:** Some of the roads in the subproject sites are narrow thus excavation and trenching works along right on the ways, hauling of construction materials and operation of equipment on- site can cause traffic problems. Potential impact is negative but short term and reversible by mitigation measures. The construction contractor will be required to:

- (i) Plan transportation routes so that heavy vehicles do not use narrow local roads, except in the immediate vicinity of delivery sites;

- (ii) Schedule transport and hauling activities during non-peak hours;
- (iii) Locate entry and exit points in areas where there is low potential for traffic congestion;
- (iv) Keep the site free from all unnecessary obstructions;
- (v) Drive vehicles in a considerate manner;
- (vi) Coordinate with Coimbatore Traffic Office for temporary road diversions and with for provision of traffic aids if transportation activities cannot be avoided during peak hours;
- (vii) Notify affected sensitive receptors by providing sign boards informing nature and duration of construction works and contact numbers for concerns/complaints.
- (viii) Provide planks across trenches in front of businesses, and ensure works are completed quickly to avoid disruption
- (ix) Avoid full street closure

177. **Socio-Economic - Income.** Sites for all projects components are carefully selected ingovernment owned lands. However few temporary shops are located in the roadsidethat are likely to be affected due to the proposed raw water transmission line. For the loss of the livelihood, compensation has been estimated and mention in the RP. For this project, in the intake location there is an acquisition for 2 acres land from private owner accordingly compensation has been worked out. The details of the compensation isgiven in the RP. During the project implementation, blocking of access to the business / livelihood activities are envisaged, especially during pipeline laying along the roads, may impact the income of households. However, given the alignment of pipeline is within the road carriage way, and also the measures suggested for ensuring accessibility during pipe laying works are notable but temporary impact is envisaged. Some shops and other premises along the roads may lose business income if the access will be impededdue to excavation of trenches, the presence of heavy vehicles and machinery, etc. Access disruption to hospitals, socio cultural places etc., will cause inconvenience to the public. Implementation of the following best construction measures will avoid the disturbance reduce the inconvenience and disturbance to the public.

- (i) Inform all businesses and residents about the nature and duration of any work well in advance so that they can make necessary preparations;
- (ii) Do not block any access; leave spaces for access between barricades/mounds of excavated soil and other stored materials and machinery, and providing footbridges so that people can crossover open trenches
- (iii) Barricade the construction area and regulate movement of people and vehicles in the vicinity, and maintain the surroundings safely with proper direction boards, lighting and security personnel – people should feel safe to move around
- (iv) Control dust generation
- (v) Immediately consolidate the backfilled soil and restore the road surface, this will also avoid any business loss due to dust and access inconvenience of construction work.
- (vi) Employee best construction practices, speed up construction work with better equipment, increase workforce, etc., in the areas with predominantly commercial, and with sensitive features like hospitals, and schools;
- (vii) Consult businesses and institutions regarding operating hours and factoring this in work schedules; and
- (viii) Provide sign boards for pedestrians to inform nature and duration of construction works and contact numbers for concerns/complaints.

178. **Socio-Economic – Employment.** Manpower will be required during the construction stage. This can result in generation of temporary employment and increase in local revenue. Thus, potential impact is positive and long-term. The construction contractor will be required to:

- (i) Employ local labour force as far as possible
- (ii) If available, secure construction materials from local market.

179. **Occupational Health and Safety.** Workers need to be mindful of the occupational hazards which can arise from working in confined areas such as trenches, working at heights, near the heavy equipment operating areas etc.,. Potential impacts are negative and long-term but reversible by mitigation measures. The construction contractor will be required to:

- (i) Follow all national, state and local labour laws (indicative list is in **Appendix-2**);
- (ii) Develop and implement site-specific occupational health and safety (OH and S) Plan which shall include measures such as: (a) safe and documented construction procedures to be followed for all site activities; (b) ensuring all workers are provided with and use personal protective equipment; (c) OH and S Training for all site personnel, (d) excluding public from the work sites; and (e) documentation of work-related accidents; Follow International Standards such as the World Bank Group's Environment, Health and Safety Guidelines.
- (iii) Ensure that qualified first aid trained professional is deployed at all times. Equipped first-aid stations shall be easily accessible throughout the sites
- (iv) Secure all installations from unauthorized intrusion and accident risks
- (v) Provide OH and S orientation training to all new workers to ensure that they are apprised of the basic site rules of work at the site, personal protective protection, and preventing injuring to fellow workers;
- (vi) Provide visitor orientation if visitors to the site can gain access to areas where hazardous conditions or substances may be present. Ensure also that visitor/s do not enter hazard areas unescorted;
- (vii) Ensure the visibility of workers through their use of high visibility vests and other PPEs when working in or walking through heavy equipment operating areas;
- (viii) Ensure moving equipment is outfitted with audible back-up alarms;
- (ix) Mark and provide sign boards for hazardous areas such as energized electrical devices and lines, service rooms housing high voltage equipment, and areas for storage and disposal. Signage shall be in accordance with international standards and be well known to, and easily understood by workers, visitors, and the general public as appropriate; and
- (x) Provide supplies of potable drinking water;
- (xi) Provide clean eating areas where workers are not exposed to hazardous or noxious substances
- (xii) Disallow worker exposure to noise level greater than 85 dB (A) for a duration of more than 8 hours per day without hearing protection. The use of hearing protection shall be enforced actively.

180. **Community Health and Safety.** Excavations along the roads & narrow streets, and hauling of equipment and vehicles have potential to create safety risks to the community. Excavations without any proper protection may endanger the close by buildings. Hazards

posed to the public, specifically in high-pedestrian areas may include traffic accidents and vehicle collision with pedestrians. Potential impact is negative but short-term and reversible by mitigation measures. The construction contractor will be required to:

- (i) Confine work areas; prevent public access to all areas where construction works are on-going through the use of barricading and security personnel
- (ii) Attach warning signs, blinkers to the barricading to caution the public about the hazards associated with the works, and presence of deep excavation
- (iii) Minimize the duration of time when the trench for laying pipe is left open through careful planning; plan the work properly from excavation to refilling and road relaying
- (iv) Control dust pollution – implement dust control measures as suggested under air quality section
- (v) Ensure appropriate and safe passage for pedestrians along the work sites
- (vi) Provide road signs and flag persons to warn of on-going trenching activities.
- (vii) Restrict construction vehicle movements to defined access roads and demarcated working areas (unless in the event of an emergency)
- (viii) Enforce strict speed limit (20-30 kmph) for plying on unpaved roads, construction tracks
- (ix) Provide temporary traffic control (e.g. flagmen) and signs where necessary to improve safety and smooth traffic flow
- (x) Where traffic is diverted around crossings, traffic control or careful selection of the exit from the working areas will be provided with the aim of ensuring that vehicles join the road in a safe manner.
- (xi) At sensitive locations particularly where there are schools and markets close to the road, awareness of safety issues will be raised through neighbourhood awareness meetings
- (xii) All drivers and equipment operators will undergo safety training
- (xiii) Maintain regularly the construction equipment and vehicles; use manufacturer-approved parts to minimize potentially serious accidents caused by equipment malfunction or premature failure

181. **Construction Camps.** Contractor may require to set up construction camps – for temporary storage of construction material (pipes, cement, steel, fixtures, fuel, lubricants etc.), and stocking of surplus soil, and may include separate living areas for migrant workers. The contractor will however be encouraged to engage local workers as much as possible. Operation of work camps can cause temporary air, noise and water pollution, and may become a source of conflicts, and unhealthy environment if not operated properly. Potential impacts are negative but short-term and reversible by mitigation measures. The construction contractor will be required to:

- (i) Select a camp site away from residential areas (at least 100 m buffer shall be maintained) or locate the camp site within the existing facilities of City Corporation
- (ii) Avoid tree cutting for setting up camp facilities
- (iii) Provide a proper fencing/compound wall for camp sites
- (iv) Camp site shall not be located near (100 m) water bodies, flood plains flood prone/low lying areas, or any ecologically, socially, archeologically sensitive areas
- (v) Separate the workers living areas and material storage areas clearly with a fencing and separate entry and exit
- (vi) Camp shall be provided with proper drainage, there shall not be any water accumulation

- (vii) Provide drinking water, water for other uses, and sanitation facilities for employees drinking water should be regularly tested to confirm that drinking water standards are met
- (viii) Prohibit employees from cutting of trees for firewood; contractor should provide cooking fuel (cooking gas); fire wood not allowed
- (ix) Train employees in the storage and handling of materials which can potentially cause soil contamination
- (x) Wastewater from the camps shall be disposed properly either into sewer system; if sewer system is not available, provide on-site sanitation with septic tank and soak pit arrangements; (100 m away from surface water body or groundwater well)
- (xi) Recover used oil and lubricants and reuse or remove from the site;
- (xii) Manage solid waste according to the following preference hierarchy: reuse, recycling and disposal to designated areas; provide a compost pit for bio degradable waste, and non-biodegradable / recyclable waste shall be collected and sold in local market
- (xiii) Remove all wreckage, rubbish, or temporary structures which are no longer required; and
- (xiv) At the completion of work, camp area shall be cleaned and restored to pre-project conditions, and submit report to PIU; PIU to review and approve camp clearance and closure of work site.

C. Operation and Maintenance Impacts

182. The WTP plant is the source for generation of noise during operation. However, the residential units are located away from the WTP. High inside noise levels can affect the health of operators and staff at the facilities, and therefore, noise levels needs to be maintained within and outside the plant at acceptable levels. To eliminate the issue, it is proposed to provide

- (i) Procure good quality latest technology pumps that guarantee controlled noise at a level of around 80 dB (A) at a distance of 1m.
- (ii) Use appropriate building materials and construction techniques for WTP, which can absorb sound rather than reflect noise.
- (iii) Use acoustic enclosures – manufacturer certified for all pumps and motors.
- (iv) Provide earplugs designated for noise reduction to workers working within the WTP, where the noise level will be within 80dB (A). Noise level will be limited to 45 dB (A) outside the WTP and at the boundary.

183. The main O&M activities of the proposed infrastructure will be detection and repair of leaks and pipe bursts. These are, however, likely to be minimal as proper design and selection of good quality pipe material should mean that leaks are minimal. Leak repair work will be similar to the pipe laying work as earlier explained. Trenches will be dug to reveal the leaking area and the faulty connection will be re-fitted, or the pipe will be removed and replaced if necessary.

184. **Recurrence of blockage and leakage problems.** Although impact is likely to be minimal due to new and well-designed efficient system; it should be ensured that leak detection and restoration time is minimized to the extent possible.

185. To ensure that water delivered to consumers at all times meets the drinking water standards, the following measures are suggested:

- (i) Preparation and implementation of a water quality surveillance as part of the project to ensure that supplied water meets the drinking water standards
- (ii) Surveillance program will be organized to ensure the water quality of the consumer water

D. Cumulative Impact Assessment

186. The Cumulative Impact Assessment (CIA) examined the interaction between the subproject's residual effects (i.e., those effects that remain after mitigation measures have been applied) and those associated with other past, existing and reasonably foreseeable future projects or activities. The interaction of residual effects associated with multiple projects and/or activities can result in cumulative impacts, both positive and negative. The subproject's potential cumulative effects were considered with respect to Valued Environmental Components (VECs) in the categories of environmental, socio-economic, and heritage resources in four areas:

- (i) Of any potential residual project effects that may occur incrementally overtime;
- (ii) Consideration of other known relevant projects or activities within the specified study area boundaries, even if not directly related to the subproject;
- (iii) Potential overlapping impacts that may occur due to other developments, even if not directly related to the proposed project ;and
- (iv) Future developments that is reasonably foreseeable and sufficiently certain to proceed.

187. The subproject IEE has identified the VECs as air quality, water (surface and groundwater) quality, noise, geophysical (hydrogeological), traffic management, social-economic and socio-community, and human health. There are no foreseeable projects that will overlap with the subproject.

188. Given the water supply requirement in Madurai municipal corporation will be met and the source from River Mullai periyar river at lower camp is considered adequate, there are no significant cumulative impacts expected on the future water supply.

189. Air quality effects will occur during construction. Consequently, although emissions of common air contaminants (CAC) and fugitive dust may be elevated in proximity to active work sites, this impact will be short-term and localized to the immediate vicinity of the alignment. Greenhouse Gas (GHG) emissions may increase as a result of project activities (i.e., vehicle and equipment operation, concrete production, disposal of excavated material, land filling of residual wastes). Given the subproject's relatively minor contribution to CAC and GHG emissions during construction, the overall significance rating of both these potential residual effects is considered to be negligible during construction.

190. During construction, noise levels in the immediate proximity of most work sites are expected to increase. The duration of this exposure will be relatively brief. This exposure represents a temporary, localized, adverse residual effect of low to moderate significance for affected receptors. Structural damage due to ground vibrations is unlikely; there may annoyance to spatially located receptors during construction. Noise levels associated with the project operations will be largely imperceptible as the service reservoirs are located in relatively small sites within the city proper.

191. Land use/traffic management concerns will occur spatially during construction. During construction, site-specific mitigation measures will be implemented to address temporary disruptions to land use and access in the vicinity of the alignment such as road and sidewalk closures, traffic delays and detours, parking modifications, and increased volumes of construction-related traffic. There should be improved traffic movement along the alignment once construction is completed. Since the subproject will be built in undeveloped land earmarked for service reservoirs purposes, it will not conflict with existing or planned land use. However, following improvement in infrastructures and services, added

residential developments, commercial and business facilities and increased densities are expected to develop and enhance the subproject area. This can be considered a long-term cumulative benefit of the subproject.

192. Adverse impacts such as localized disruption of vehicle traffic and pedestrian movements in areas along the alignment, and elevated CAC and fugitive dust emissions in proximity to work sites, elevated noise and vibration levels and visual impacts will occur during construction. These short-term effects will be mitigated by providing alternate travel routes or alternating traffic movements and, where possible, access to businesses, schools and residences. However, upon completion of construction the socio-community will benefit from improved water supply system. This is considered a long-term cumulative benefit.

193. Development at the intake and water treatment plant sites and in the vicinity of the subproject may result in similar impacts relative to water quality and soils, but each impacts are independent of one another and are mitigated on a site-specific basis. Further, while water quality impacts have the ability to compound when taking into account regional water basins into consideration, the subproject will be required to adhere to the mandatory state and local laws, ordinances, regulations, and water quality standards. Regional geologic impacts do not generally compound, and are limited to the site at which they occur.

194. No adverse residual effects to human health will occur as a result of subproject construction or operation. While exposure to elevated noise levels and fugitive dust and CAC emissions will occur in proximity to subproject work sites during construction, due to their short-term, localized nature, these effects are expected to be minor and insignificant with no measurable effects on human health. The subproject operations will benefit the general public by contributing to the long-term improvement of water supply system and community livability in Madurai Municipal Corporation.

VI. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

A. Overview

195. The active participation of stakeholders including local community, NGOs, etc., in all stages of project preparation and implementation is essential for successful implementation of the project. It will ensure that the subprojects are designed, constructed, and operated with utmost consideration to local needs, ensures community acceptance, and will bring maximum benefits to the people. Public consultation and information disclosure is necessary as per the ADB policy.

196. Most of the main stakeholders have already been identified and consulted during preparation of this IEE, and any others that are identified during project implementation will be brought into the process in the future. Primary stakeholders of the subproject are residents, shopkeepers and businesspeople who live and work near sites where facilities will be built (OHT), government and utility agencies responsible for provision of various services in project area. Secondary stakeholder are NGOs and CBOs working in the area, community representatives, beneficiary community in general, government agencies, TNUIFSL and Government of Tamil Nadu.

B. Public Consultation

197. The public consultation and disclosure program is a continuous process throughout the project implementation, including project planning, design and construction.

a) Consultation during Project Preparation

198. The subproject proposal is formulated by Madurai Municipal Corporation in consultation with the public representatives in the project area to suit their requirements and as per Central Public Health and Environmental Engineering Organisation (CPHEEO) norms.

199. Focus-group discussions with the local public and other stakeholders were conducted to learn their views and concerns. General public and the people residing along the project activity areas were also consulted. A project area level consultation workshop was conducted with the public representatives and prominent citizens, NGOs etc., on 08.03.2018 at conference hall, 13.03.2018 at Uthamapalayam, 16.03.2018 at Pennycuick hall and 16.03.2018 at Collectors office. (Details are enclosed as **Appendix 9**).

200. A total of 56 OHT locations has been identified for water distribution under the "Dedicated Water Supply Scheme for Madurai Corporation from Mullai Periyar at Lower camp". Out of 56 OHT's, 24 OHT locations were identified for conducting public consultations, which was held from 13th February 2019 to 15th February 2019. The locations were selected based on the presence of socially important locations including the public park area, playground, burial ground, temples etc., consultation was held. The outcome of the consultation has been enclosed as **Appendix 16**.

201. It was observed that people are willing to extend their cooperation, as the proposed project will provide protected water supply for their households, which will enhance basic infrastructure service levels and overall living standard of the public. Also they are expecting that the work should be implemented at the earliest. Public demanded for advance notice before construction and proper warning signs along the construction area to avoid

inconvenience and the project completed within the stipulated contract period. The road should be restored properly after the pipe laying work completed.

b) Consultation during construction

202. Prior to start of construction, PIU will conduct information dissemination sessions at various places and solicit the help of the local community, leaders/prominent for the project work. Focus group meetings, as required, will be conducted to discuss and plan construction work (mainly pipeline work) with local communities to reduce disturbance and other impacts and also regarding the project grievance redress mechanism. Project information and construction schedule will be provided to the public. A constant communication will be established with the affected communities to redress the environmental issues likely to surface during construction phase. Contractor will provide prior public information (in Tamil and English) about the construction work in the area, once 7 days prior to the start of work and again a day before the start of work via pamphlets (a sample public information template is provided in **Appendix 8**). At the work sites, public information boards will also be provided to disseminate project related information.

C. Information Disclosure

203. Executive summary of the IEE will be translated in Tamil and made available at the offices of PMU and PIU and also displayed on their notice boards. Hard copies of the IEE will be accessible to citizens as a means to disclose the document and at the same time creating wider public awareness. Electronic version of the IEE in English and Executive Summary in Tamil will be placed in the official website of the TNUIFSL and Madurai Municipal Corporation after approval of the IEE by the ADB. Stakeholders will also be made aware of grievance register and redress mechanism.

204. Public information campaigns to explain the project details to a wider population will be conducted. Public disclosure meetings will be conducted at key project stages to inform the public of progress and future plans. Prior to start of construction, the PIU will issue notification on the start date of implementation in local newspapers. A board showing the details of the project will be displayed at the construction sites for the information of general public.

205. Local communities will be continuously consulted regarding location of construction camps, access and hauling routes and other likely disturbances during construction. The road closure together with the proposed detours will be communicated via advertising, pamphlets, radio broadcasts, road signage, etc.

VII. GRIEVANCE REDRESS MECHANISM

206. A common GRM will be in place to redress social, environmental or any other project related grievances. The GRM described below has been developed in consultation with stakeholders. Public awareness campaign will be conducted to ensure that awareness on the project and its grievance redress procedures is generated. The campaign will ensure that the poor, vulnerable and others are made aware of grievance redress procedures and entitlements per project entitlement matrix, and Project Management Unit(PMU) and concerned Project Implementation Unit (PIU) will ensure that their grievances are addressed.

207. Affected persons will have the flexibility of conveying grievances/suggestions by dropping grievance redress/suggestion forms in complaints/suggestion boxes or through telephone hotlines at accessible locations, by e-mail, by post, or by writing in a complaints register in Madurai Corporation offices. Madurai Corporationsafeguards officer will have the responsibility for timely grievance redress on safeguards and gender issues and for registration of grievances, related disclosure and communication with the aggrieved party.

208. GRM provides an accessible, inclusive, gender-sensitive and culturally appropriate platform for receiving and facilitating resolution of affected persons' grievances related to the project. A two-tier grievance redress mechanism is conceived, one, at project level and another, beyond project level. For the project level GRM, a Grievance Redress Cell (GRC) will be established in PIU/Madurai CityMunicipal Corporation; Safeguards officer, supported by the Deputy Construction Manager, along with support Engineer – Construction management Supervision Consultant (Non key expert) and social, gender and environmental safeguards of CMSC will be responsible for creating awareness among affected communities and help them through the process of grievance redress, recording and registering grievances of non-literate affected persons.

209. GRM aims to provide a time-bound and transparent mechanism to voice and resolve social and environmental concerns linked to the project. All grievances – major or minor, will be registered. Documentation of the name of the complainant, date of receipt of the complaint, address/contact details of the person, location of the problem area, and how the problem was resolved will be undertaken. Madurai Municipal Corporation will also be responsible for follow-through for each grievance, periodic information dissemination to complainants on the status of their grievance and recording their feedback (satisfaction/dissatisfaction and suggestions).

210. In case of grievances that are immediate and urgent in the perception of the complainant, the contractor, and supervision personnel of the CMSC and PIU will resolve the issue on site, and any issue that is not resolved at this level will be dealt at PIU head level for immediate resolution. Should the PIU fail to resolve any grievance within the stipulated time period, the unresolved grievances will be taken up at MCMC level. In the event that certain grievances cannot be resolved even at MCMC level., particularly in matters related to land purchase/acquisition, payment of compensation, environmental pollution etc., they will be referred to the Grievance Redress Committee (GRC) headed by the District Collector. Any issue which requires higher than district level inter-departmental coordination or grievance redress, will be referred to the State level Steering Committee.

211. Grievance Redress Committee (GRC) will meet every month (if there are pending, registered grievances), determine the merit of each grievance, and resolve grievances within specified time upon receiving the complaint-failing which the grievance will be addressed by the state-level Steering Committee (SC). The SC will resolve escalated/unresolved grievances received.

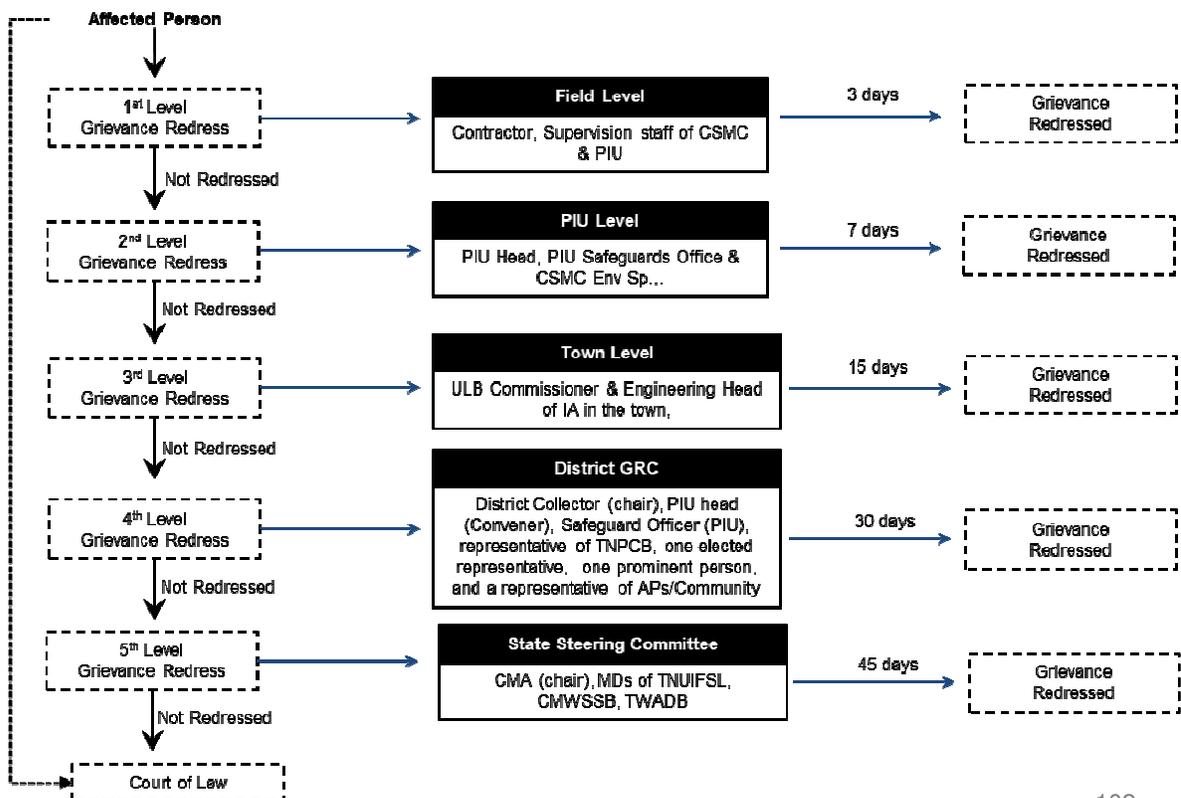
212. **Composition of GRC.**GRC will be headed by the District Collector, and members include PIU head, Safeguards Officer of PIU, representative of TNPCB, one elected representative / prominent citizen from the area, and a representative of affected community. GRC must have a women member.

213. **State level steering committee** will include Commissioner of Municipal Administration as chair, member include managing directors of TNUIFSL, Chennai Metropolitan Water Supply and Sewerage Board, TWAD Board and others as necessary..

214. **Areas of Jurisdiction.**The areas of jurisdiction of the GRC, headed by the District Collector will be (i) all locations or sites within the district where subproject facilities are proposed, or (ii) their areas of influence within the District. The Steering Committee will have jurisdictional authority across the state (i.e., areas of influence of subproject facilities beyond district boundaries, if any).

215. The multi-tier GRM for the project is outlined below (**Figure 19**), each tier having time-bound schedules and with responsible persons identified to address grievances and seek appropriate persons' advice at each stage, as required. The GRC will continue to function throughout the project duration. The implementing agencies/ULBs shall issue notifications to establish the respective PIU level grievance redress cells, with details of composition, process of grievance redress to be followed, and time limit for grievance redress at each level.

Figure 19: Proposed TNUFIP Grievance Redress Mechanism



AP = affected person, CMA = Commissionerate of Municipal Administration, CMWSSB = Chennai Metropolitan Water Supply and Sewerage Board, CMSC = Construction, Management and Supervision Consultant, GRC = grievance redress committee, IA = implementing agency, PIU = Project Implementation Unit, TNUIFSL = Tamil Nadu Urban Infrastructure Financial Services Limited, TWADB = Tamil Nadu Water and Drainage Board, ULB = urban local body.

216. **Recordkeeping.** Records of all grievances received, including contact details of complainant, date the complaint was received, nature of grievance, agreed corrective actions and the date these were effected and final outcome will be kept by PIU in Madurai Corporation (with the support of CMSC) and submitted to PMU.

217. **Information dissemination methods of the GRM.** The PIU, assisted by CMSC will be responsible for information dissemination to affected persons and general public in the project area on grievance redress mechanism. Public awareness campaign will be conducted to ensure that awareness on the project and its grievance redress procedures is generated. The campaign will ensure that the poor, vulnerable and others are made aware of grievance redress procedures and entitlements per agreed entitlement matrix including. whom to contact and when, where/ how to register grievance, various stages of grievance redress process, time likely to be taken for redress of minor and major grievances, etc. Grievances received and responses provided will be documented and reported back to the affected persons. The number of grievances recorded and resolved and the outcomes will be displayed/disclosed in the PIU, offices, ULB notice boards and on the web, as well as reported in the semi-annual environmental and social monitoring reports to be submitted to ADB. A Sample Grievance Registration Form has been attached in **Appendix 3**.

218. **Periodic review and documentation of lessons learned.** The PMU will periodically review the functioning of the GRM and record information on the effectiveness of the mechanism, especially on the PIU's ability to prevent and address grievances.

219. **Costs.** All costs involved in resolving the complaints (meetings, consultations, communication and reporting/information dissemination) will be borne by Madurai Municipal Corporation. Cost estimates for grievance redress are included in resettlement cost estimates.

220. **Country legal procedure.** An aggrieved person shall have access to the country's legal system at any stage, and accessing the country's legal system can run parallel to accessing the GRM and is not dependent on the negative outcome of the GRM.

221. **ADB's Accountability Mechanism.** In the event that the established GRM is not in a position to resolve the issue, the affected person also can use the ADB Accountability Mechanism through directly contacting (in writing) the Complaint Receiving Officer (CRO) at ADB headquarters or the ADB India Resident Mission. The complaint can be submitted in any of the official languages of ADB's developing member countries. Before submitting a complaint to the Accountability Mechanism, it is recommended that affected people make a good faith effort to resolve their problems by working with the concerned ADB operations department (in this case, the resident mission). Only after doing that, and if they are still dissatisfied, they could approach the Accountability Mechanism. The ADB Accountability Mechanism information will be included in the project-relevant information to be distributed to the affected communities, as part of the project GRM.

VIII. ENVIRONMENTAL MANAGEMENT PLAN

222. An Environmental Management Plan (EMP) has been developed to provide mitigation measures to reduce all negative impacts to acceptable levels.

223. The EMP will guide the environmentally sound construction of the subproject and ensure efficient lines of communication between TNUIFSL, PMU, Implementing agency, PIU, Consultants and Contractors. The EMP will (i) ensure that the activities are undertaken in a responsible non-detrimental manner; (ii) provide a pro-active, feasible and practical working tool to enable the measurement and monitoring of environmental performance on site (iii) guide and control the implementation of findings and recommendations of the environmental assessment conducted for the subproject; (iv) detail specific actions deemed necessary to assist in mitigating the environmental impact of the subproject; and (v) ensure that safety recommendations are complied with. The EMP includes a monitoring program to measure the environmental condition and effectiveness of implementation of the mitigation measures. It will include observations on- and off-site, document checks, and interviews with workers and beneficiaries.

224. The contractor will be required to submit to PIU/Madurai CityMunicipal Corporation, for review and approval, a Site Environmental Management Plan (SEMP) including (i) proposed sites/locations for construction work camps, storage areas, hauling roads, lay down areas, disposal areas for solid and hazardous wastes; (ii) specific mitigation measures following the approved EMP; and (iii) monitoring program as per SEMP. No works are allowed to commence prior to approval of SEMP.

225. A copy of the EMP/approved SEMP will be kept on site during the construction period at all times. The EMP included in the bid and contract documents to ensure compliance to the conditions set out in this document.

226. For civil works, the contractor will be required to (i) carry out all of the mitigation and monitoring measures set forth in the approved EMP; and (ii) implement any corrective or preventative actions set out in safeguards monitoring reports that the employer will prepare from time to time to monitor implementation of this IEE, EMP and SEMP. The contractor shall allocate budget for compliance with these IEE, EMP and SEMP measures, requirements and actions.

227. The following tables show the potential environmental impacts, proposed mitigation measures and responsible agencies for implementation and monitoring.

Table 42: Design Stage Environmental Impacts and Mitigation Measures

| Field | Anticipated Impact | Mitigation Measures | Responsibility of Mitigation | Cost and Source of Funds |
|--|---|---|------------------------------|--------------------------|
| Water Treatment Plant | Deficient treatment due to substandard operation / system malfunction | (i) Design process to meet the Indian Standards for Drinking Water - Specification (IS 10500:2012). Ensuring continuous uninterrupted power supply. (ii) Providing operating manual with all standard operating procedures (SOPs) for operation and maintenance of the facility (iii) Necessary training to ULB staff dealing with WTP. (iv) Extended contractor period for O&M, proper transfer of facility to ULB with adequate technical know-how on O&M and hands-on training to ULB staff | PIU | Project Costs |
| | Disposal of Sludge | (i) After drying, the dried sludge will be stored in stockyard within the WTP premises and it will be disposed periodically or in the area identified by the Madurai Municipal Corporation at a maximum distance of 30 km from WTP. (ii) The water from sludge drying bed under drain is recirculated in to recirculation sump. The supernatant water from Sludge Thickener will be sent into re-circulation sump. The sludge shall be taken to the sludge balance tank and from there discharge to nearby drain. The filtrate will be re-circulated to the raw water distribution chamber | PIU | Project Costs |
| | Storage of chemicals and other hazardous materials | (i) The separate place in the WTP site should be identified for the safe storage and handling of chemicals and other hazardous materials with proper display of requirements and marking as protected area. (ii) Providing specific appliances for safe working of personnel in critical areas like chlorination plant shall be ensured. | PIU | Project Costs |
| | Reuse of Back wash water | The backwash water from proposed WTP should be stored within the premises for further recirculation. It helps to minimize the raw water demand. For reuse and recirculation of the back wash water, proper recirculation system should be installed in WTP. | PIU | Project Costs |
| | Risk and Safety | (i) Adopt the World Bank EHS guidelines related to occupational health and safety (refer https://www.ifc.org/wps/wcm/connect/e22c050048855ae0875cd76a6515bb18/Final%2B-%2BWater%2Band%2BSanitation.pdf?MOD=AJPERES) (ii) Use only liquid chlorine. Strictly, the chlorine gas will not be used in the water treatment plant. | | |
| Distribution network - raw water main, clear water transmission main | Nuisance due to leaks, overflows, contamination of water, occupation health and safety of | (i) Limit the depth wherever possible (ii) In unavoidable cases, where networks are to be laid close to storm water drains, appropriate pipe material shall be selected (stoneware pipes shall be avoided) (iii) For shallow depth and especially in narrow roads, use small inspection chambers ; | PIU | Project Costs |

| Field | Anticipated Impact | Mitigation Measures | Responsibility of Mitigation | Cost and Source of Funds |
|---------------------------|--------------------|---|------------------------------|--------------------------|
| | workers, etc. | | | |
| Over Head Tanks | Energy consumption | (i) Using low-noise and energy efficient pumping systems (ii) Efficient Pumping system operation (iii) Installation of Variable Frequency Drives (VFDs) | PIU | Project Costs |
| Trees on Project Location | Tree cutting | (i) Minimize removal of trees by adopting to site condition and with appropriate layout design/alignment, (ii) Obtain prior permission for tree cutting (iii) Plant and maintain 10 trees for each tree that is removed | PIU | Project Costs |

Table 43: Pre Construction Stage Environmental Impacts and Mitigation Measures

| Field | Anticipated Impact | Mitigation Measures | Responsible for Implementation | Cost and Source of Funds |
|--|--|---|--------------------------------|--------------------------|
| Construction of Check dam and Head works | Change of stream course due to diversion channels to construct intake structures and Check dam | (i) No appreciable change to the river course shall occur due to diversion channel and intake structures & check dam should be constructed accordingly. (ii) The cofferdam will be provided for construction of check dam and head work without any disturbance of river water flow. | Contractor / PIU | Project Costs |
| | Protection of Top soil | Top soil from the Head works site should be stored in stock piles and that can be used for gardening purposes at Head works site which will be an environmental enhancing measure | Contractor/ PIU | Project Costs |
| | Disposal of construction debris and excavated materials. | The contractor should make use of the excavated material and construction debris for service road construction purpose. | Contractor / PIU | Project Costs |
| | Downstream users (impacts arising due to cofferdams, etc.) | Ensure that the stream is not obstructed, affecting the downstream users due to cofferdams, etc. | Contractor / PIU | Project Costs |
| | Water quality in the source / water bodies | Establish the baseline water quality prior to initiation of construction and to be periodically monitored. | Contractor / PIU | Project Costs |

| Field | Anticipated Impact | Mitigation Measures | Responsible for Implementation | Cost and Source of Funds |
|---|--|--|--------------------------------|--------------------------|
| | Restoring river bed / water source | After completion of work, ensure the restoring of river bed to its natural shape free from any debris or construction junk material that may obstruct the flow. | Contractor / PIU | |
| | Safety measures | <ul style="list-style-type: none"> i) Barricading of construction site/ trench locations at all times in a day with adequate signage. ii) Where loose soil is met with, shoring and strutting shall be provided to avoid collapse of soil. iii) The contractor shall supply all necessary safety appliances such as safety goggles, helmets, safety belts, earplugs, mask etc., to workers and staff. | Contractor / PIU | Project Costs |
| Construction of transmission lines including OHTs , WTP | Compensatory plantation of trees | Compensatory plantation of atleast ten the number trees felled should be done in line with competent authority guidelines | Contractor / PIU | Project Costs |
| | Disposal of construction debris and excavated materials. | <p>The Contractor shall identify the sites for debris disposal and should be finalized prior to start of the earthworks; taking into account the following</p> <ul style="list-style-type: none"> a) The dumping does not impact natural drainage courses b) no endangered / rare flora is impacted by such dumping c) The dumping site should be located at least 1.0 km away Settlement area. d) Dumping site should be located in nonresidential areas in the downwind side e) It should be located at least 100m from the designated forest land. f) Avoid disposal on productive land. g) Minimize the construction debris by balancing the cut and fill requirements. | Contractor / PIU | Project Costs |
| | Protection of top soil | The top soil to be protected and compacted after completion of work, where the pipelines run, including open lands and agricultural lands. | Contractor | Project Costs |
| | Safety Aspects | <ul style="list-style-type: none"> (i) Adequate precautions shall be taken to prevent the accidents and from the machineries. All machines used shall conform to the relevant Indian standards Code and shall be regularly inspected by the PIU. (ii) Adequate precautions shall be taken while carrying out excavation, laying pipelines, operation of machinery near the power transmission towers and lines. Safety clearance | Contractor | Project Costs |

| Field | Anticipated Impact | Mitigation Measures | Responsible for Implementation | Cost and Source of Funds |
|----------------------------|--|--|--------------------------------|--------------------------|
| | | <p>requirements shall be met with.</p> <ul style="list-style-type: none"> (iii) Labourers shall be periodically trained for the safety precautions for working near the power transmission lines. (iv) Emergency contact numbers shall be made available at the place of work. (v) Where loose soil is met with, shoring and strutting shall be provided to avoid collapse of soil. (vi) Protective footwear and protective goggles should be provided to all workers employed on mixing of materials like cement, concrete etc. (vii) Welder's protective eye-shields shall be provided to workers who are engaged in welding works. (viii) Earplugs shall be provided to workers exposed to loud noise, and workers working in crushing, compaction, or concrete mixing operation. (ix) The contractor shall supply all necessary safety appliances such as safety goggles, helmets, safety belts, earplugs, mask etc., to workers and staffs. (x) The contractor will make sure that during the construction work all relevant provisions of the Factories Act, 1948 and the Building and other Construction Workers (regulation of Employment and Conditions of Services) Act, 1996 are adhered to. (xi) The contractor shall not employ any person below the age of 14 years for any work and no woman will be employed on the work of painting with products containing lead in any form. | | |
| Batching and Crusher plant | Setting up of Batching and Crushers Plant, | <ul style="list-style-type: none"> i) Hot mix plants, crushers and Ready mix concrete batching plants shall be located at least 500 m away from the nearest habitation. ii) Contractor shall obtain NOCs / Consent to Establishment & Operate the plants from the Tamil Nadu State Pollution Control Board (TNPCB) and submit a copy to the PIU. iii) Specifications of hot mix plants and batching plants, other construction vehicles, equipment and machinery to be procured will comply to the relevant Bureau of Indian Standard (BIS) norms and with the requirements of the relevant current emission control legislations | Contractor | Project Costs |

| Field | Anticipated Impact | Mitigation Measures | Responsible for Implementation | Cost and Source of Funds |
|----------------------|--|--|---|--------------------------|
| | Water for construction | <ul style="list-style-type: none"> (i) The contractor should source the requirement of water preferentially from surface water bodies, such as rivers and tank in the project area. Boring of any tube wells are prohibited. To avoid disruption / disturbance to other water users, the contractor should extract water from fixed locations. (ii) Only at locations where surface water sources are not available, the contractors can contemplate extraction of groundwater. Consent from the PIU engineer that no surface water resource is available in the immediate area for the project is a pre – requisite prior to extraction of groundwater. The contractor must need to comply with the requirements of the State Groundwater Department and seek their approval for doing so. (iii) The use of surface water by the contractor should be allowed only after written permission/consent of the community/panchayat/ owner indicating the quantum of water allowed to be drawn. | Contractor | Project cost |
| Sources of Materials | Extraction of materials can disrupt natural land contours and vegetation resulting in accelerated erosion, disturbance in natural drainage patterns, ponding and water logging, and water pollution. | <ul style="list-style-type: none"> (i) Obtain construction materials only from government approved quarries with prior approval of PIU (ii) PIU to review, and ensure that proposed quarry sources have all necessary clearances/ permissions in place prior to approval (iii) Contractor to submit to PIU on a monthly basis documentation on material obtained from each sources (quarry/ borrow pit) (iv) Avoid creation of new borrow areas, quarries etc., for the project; if unavoidable, contractor to obtain all clearances and permissions as required under law, including Environmental Clearance (EC) prior to approval by PIU | Contractor to prepare list of approved quarry sites and sources of materials with the approval of PIU | Project cost |
| | Identification and selection of Quarries | <ul style="list-style-type: none"> (i) The contractor should source materials (like gravel, aggregates) from existing licensed quarries with the suitable materials for construction. (ii) Apart from approval of the quality of the quarry materials, the engineer's (PIU) representative will verify the legal status of the quarry operation, as to whether approval under Mining Department is obtained. | Contractor in coordination with PIU | Project cost |
| | Sand | The contractor will identify sand quarries with requisite approvals for the extraction of sand under Tamil Nadu Minor Minerals Concession Rules, 1959 (Corrected upto 31.3.2001 or latest) for | Contractor in coordination with | Project cost |

| Field | Anticipated Impact | Mitigation Measures | Responsible for Implementation | Cost and Source of Funds |
|--|---|---|--|--------------------------|
| | | use in the project. | PIU | |
| Submission of updated EMP / SEMP; EMP implementation and reporting | Unsatisfactory compliance to EMP | (i) Appoint EHS Supervisor by CMSC to ensure EMP implementation (ii) Submission of updated EMP/ SEMP (iii) Timely submission monthly of monitoring reports including documentary evidence on EMP implementation such as photographs | Contractor | Contractor cost |
| Utilities | Telephone lines, electric poles and wires, water lines within proposed project area | (i) Identify and include locations and operators of these utilities in the detailed design documents to prevent unnecessary disruption of services during construction phase; and (ii) Require construction contractors to prepare a contingency plan to include actions to be taken in case of unintentional interruption of services. | Contractor & PIU | Project cost |
| Construction work camps, stockpile areas, storage areas, and disposal areas. | Conflicts with local community; disruption to traffic flow and sensitive receptors | (i) Prioritize areas within or nearest possible vacant space in the project location; (ii) If it is deemed necessary to locate elsewhere, consider sites that will not promote instability and result in destruction of property, vegetation, irrigation, and drinking water supply systems; (iii) Do not consider residential areas; (iv) Take extreme care in selecting sites to avoid direct disposal to water body, which will inconvenience the community. (v) For excess spoil disposal, ensure (a) site shall be selected preferably from barren, infertile lands. In case agricultural land needs to be selected, written consent from landowners (not lessees) will be obtained; (b) debris disposal site shall be at least 200 m away from surface water bodies; (c) no residential areas shall be located within 100 m downwind side of the site; and (d) site is minimum 100 m away from sensitive locations like settlements, ponds/lakes or other water bodies. | Contractor to finalize locations in consultation and approval of PIU | Contractor cost |

| Field | Anticipated Impact | Mitigation Measures | Responsible for Implementation | Cost and Source of Funds |
|---|---|--|--------------------------------|---|
| Consents, permits, clearances, NOCs, etc. | Failure to obtain necessary consents, permits, NOCs, etc. can result to design revisions and/or stoppage of works | <ul style="list-style-type: none"> (i) Obtain all necessary consents, permits, clearance, NOCs, etc. prior to award of civil works. (ii) Ensure that all necessary approvals for construction to be obtained by contractor are in place before start of construction (iii) Acknowledge in writing and provide report on compliance all obtained consents, permits, clearance, NOCs, etc. | Contractor and PIU | Cost of obtaining all consents, permits, clearance, NOCs, etc. prior to start of civil works responsibility of PIU |
| Chance finds | Damage / disturbance to artifacts | <ul style="list-style-type: none"> (i) Construction contractors to follow these measures in conducting any excavation work (ii) Create awareness among the workers, supervisors and engineers about the chance finds during excavation work (iii) Stop work immediately to allow further investigation if any finds are suspected; (iv) Inform Archeological Survey of India / State Archaeological Department if a find is suspected, and taking any action they require to ensure its removal or protection in situ. | Contractor and PIU | Contractor cost |

| Field | Anticipated Impact | Mitigation Measures | Responsible for Implementation | Cost and Source of Funds |
|----------------------------|---|--|--------------------------------|--------------------------|
| Works in proposed area | Degradation of water quality due to entry of silt laden runoff | <ul style="list-style-type: none"> (i) No earthworks should be conducted during the monsoon season in general, and in particular no earth work to be conducted in subproject areas during monsoon season (ii) Stockpiled material and earth/soil shall be properly covered with tarpaulins; bunds, silt traps/fences, etc., (iii) Install temporary silt traps or sedimentation basins along the drainage leading to the water bodies; it shall be ensured that no silt laden runoff or traces of fuels, lubricants or chemicals used in construction drains into any public areas. (iv) Place storage areas for fuels and lubricants away from any drainage leading to water bodies; (v) Store fuel, construction chemicals etc., on an impervious floor, also avoid spillage by careful handling; provide spill collection sets for effective spill management (vi) No workers camp sites, storage areas etc., will not be located close to the wetland (< 1 km). | Contractor and PIU | Project cost |
| Temporary economic impacts | Disruption to vendors, hawkers on ROW during sewer laying works | <ul style="list-style-type: none"> (i) Contractor is required to provide notice to the shop owners of the need to shift kiosk/wares displayed on ROW as soon as the work plan is ready, with minimum 7 working days. (ii) No works can be commenced unless 100% shifted in sections ready for implementation. | Contractor and PIU | Project cost |

Table 44: Construction Stage Environmental Impacts and Mitigation Measures

| Field | Anticipated Impact | Mitigation Measures | Responsible for Mitigation | Cost and Source of Funds |
|-------------|--|---|----------------------------|--------------------------|
| Air Quality | Dust, emissions from construction vehicles, equipment, and machinery used for installation of pipelines resulting to dusts and increase in concentration of vehicle-related pollutants such as carbon monoxide, sulfur oxides, particulate matter, nitrous oxides, and hydrocarbons. | <p>For all construction works</p> <ul style="list-style-type: none"> (i) Provide a dust screen (6m high) around the construction sites (ii) Damp down the soil and any stockpiled material on site by water sprinkling;(3-4 times a day - before the start of work, 1-2 times in between, and at the end of the day); when working in the roads there should permanently be one person responsible for directing when water sprinkling needs to take place to stop the dust moving; (iii) Reduce the need to sprinkle water by stabilizing surface soils where loaders, support equipment and vehicles will operate by using water and maintain surface soils in a stabilized condition (iv)Apply water prior to leveling or any other earth moving activity to keep the soil moist throughout the process (v) Cover the soil stocked at the sites with tarpaulins, and surround by dust screens. (vi)Control access to work area, prevent unnecessary movement of vehicle, public trespassing into work areas; limiting soil disturbance will minimize dust generation (vii)Use tarpaulins to cover the loose material (soil, sand, aggregate etc.) when transported by open trucks; minimize the drop height when moving the excavated soil. (viii)Control dust generation while unloading the loose material (particularly aggregate, sand, soil) at the site by sprinkling water and unloading inside the barricaded area (ix)Clean wheels and undercarriage of haul trucks prior to leaving construction site (x)Ensure that all the construction equipment, machinery are fitted with pollution control devises, which are operating correctly, and have a valid pollution under control (PUC) certificate <p>For pipe laying works</p> <ul style="list-style-type: none"> (i) Barricade the construction area using hard barricades (of 2 m height) on both sides (ii) Initiate site clearance and excavation work only after barricading of the site is | Contractor | Project Cost |

| Field | Anticipated Impact | Mitigation Measures | Responsible for Mitigation | Cost and Source of Funds |
|-------|--------------------|---|----------------------------|--------------------------|
| | | <p>done</p> <ul style="list-style-type: none"> (iii) Confine all the material, excavated soil, debris, equipment, machinery (excavators, cranes etc.), to the barricaded area (iv) Limit the stocking of excavated material at the site; remove the excess soil from the site immediately to the designated disposal area (v) Undertake the work section wise: a 500 m section should be demarcated and barricaded; open up several such sections at a time, but care shall be taken to locate such sections in different zones (vi) Conduct work sequentially - excavation, Pipe laying, backfilling; testing section-wise (for a minimum length as possible) so that backfilling, stabilization of soil can be done. (vii) Remove the excavated soil of first section to the disposal site; as the work progresses sequentially, by the time second section is excavated, the first section will be ready for back filling, use the freshly excavated soil for back filling, this will avoid stocking of material, and minimize the dust. (viii) Backfilled trench at any completed section after removal of barricading will be the main source of dust pollution. The traffic, pedestrian movement and wind will generate dust from backfilled section. Road restoration shall be undertaken immediately. (ix) Immediately consolidate the backfilled soil and restore the road surface; if immediate road restoration is not possible, provide a layer of plain cement concrete (PCC) of suitable mix on the backfilled trench so that dust generation, erosion is arrested and it will also provide a smooth riding surface for the traffic until the road is properly restored. Backfilled trench without any road restoration is a major source of dust. | | |

| Field | Anticipated Impact | Mitigation Measures | Responsible for Mitigation | Cost and Source of Funds |
|-----------------------|--|--|----------------------------|--------------------------|
| Surface water quality | <p>Mobilization of settled silt materials, and chemical contamination from fuels and lubricants during construction can contaminate nearby surface water quality.</p> <p>Ponding of water in the pits / foundation excavations</p> | <ul style="list-style-type: none"> (i) All earthworks be conducted during the dry season to prevent the problem of soil/silt run-off during rains (ii) Avoid stockpiling of earth fill especially during the monsoon season unless covered by tarpaulins or plastic sheets do not stock earth/material close to water bodies (at least 100 m) (iii) Prioritize re-use of excess spoils and materials in the construction works. If spoils will be disposed, only designated disposal areas shall be used; (iv) Install temporary silt traps, oil traps, or sedimentation basins along the water leading to the water bodies; it shall be ensured that no silt laden runoff or traces of fuels, lubricants or chemicals used in construction drains into nearby water bodies. (v) Place storage areas (with impermeable surface) for fuels and lubricants away from any drainage leading to water bodies; these should be at least 100 m away from water bodies and groundwater wells) (vi) Store fuel, construction chemicals etc., on an impervious floor, also avoid spillage by careful handling; provide spill collection sets for effective spill management (vii) Dispose any wastes generated by construction activities in designated sites; (viii) Conduct surface quality inspection according to the Environmental Monitoring Plan (Table 50&51). | Contractor | Project Cost |
| | Water accumulation in trenches/pits | <ul style="list-style-type: none"> (i) As far as possible control the entry of runoff from upper areas into the excavated pits, and work area by creation of temporary drains or bunds around the periphery of work area (ii) Pump out the water collected in the pits / excavations to a temporary sedimentation pond; dispose off only clarified water into drainage channels/streams after sedimentation in the temporary ponds (iii) Consider safety aspects related to pit collapse due to accumulation of water | Contractor | Project Cost |
| Noise Levels | Increase in noise level due to earth-moving and excavation equipment, and the transportation of equipment, materials, and | <ul style="list-style-type: none"> (i) Plan activities in consultation with PIU so that activities with the greatest potential to generate noise are conducted during periods of the day which will result in least disturbance especially near schools and other sensitive receptors (ii) Minimize noise from construction equipment by using vehicle silencers, fitting jackhammers with noise-reducing mufflers, and use portable street barriers to minimize sound impact to surrounding sensitive receptor; and (iii) Maintain maximum sound levels not exceeding 70 decibels (dB(A)) when measured at a distance of 10 m or more from the vehicle/s. | Contractor | Project Cost |

| Field | Anticipated Impact | Mitigation Measures | Responsible for Mitigation | Cost and Source of Funds |
|---|---|--|----------------------------|--------------------------|
| | people, and vibration | <ul style="list-style-type: none"> (iv) Identify any buildings at risk from vibration damage and avoiding any use of pneumatic drills or heavy vehicles in the vicinity; if any building at risk, structural survey be completed prior to work, to provide baseline in case any issues from vibration, and if building is structurally unsound that measures taken to avoid any further damage (v) Horns should not be used unless it is necessary to warn other road users or animals of the vehicle's approach; (vi) Consult local communities in advance of the work to identify and address key issues, and avoid working at sensitive times, such as night times religious and cultural festivals. | | |
| Landscape and aesthetics – waste generation | Impacts due to excess excavated earth, excess construction materials, and solid waste such as removed concrete, wood, packaging materials, empty containers, spoils, oils, lubricants, and other similar items. | <ul style="list-style-type: none"> (i) Prepare and implement a Construction Waste Management Plan (refer Appendix 4) (ii) As far as possible utilize the debris and excess soil in construction purpose, for example for raising the ground level or construction of access roads etc., (iii) Avoid stockpiling any excess spoils at the site for long time. Excess excavated soils should be disposed off to approved designated areas immediately (iv) If disposal is required, the site shall be selected preferably from barren, infertile lands; sites should be located away from residential areas, forests, water bodies and any other sensitive land uses (v) Domestic solid wastes should be properly segregated in biodegradable and non-biodegradable for collection and disposal to designated solid waste disposal site; create a compost pit (with impermeable bottom and sides) at workers camp sites for disposal of biodegradable waste; non-biodegradable / recyclable material shall be collected separately and sold in the local recycling material market (vi) Residual and hazardous wastes such as oils, fuels, and lubricants shall be disposed off via licensed (by TNPCB) third parties; (vii) Prohibit burning of construction and/or domestic waste; (viii) Ensure that wastes are not haphazardly thrown in and around the project site; provide proper collection bins, and create awareness to use the dustbins. recycle waste material where possible. (ix) Conduct site clearance and restoration to original condition after the completion of construction work; PIU to ensure that site is properly restored prior to issuing of construction completion certificate | Contractor | Project Cost |

| Field | Anticipated Impact | Mitigation Measures | Responsible for Mitigation | Cost and Source of Funds |
|---------------------------------------|---|---|----------------------------|--------------------------|
| Accessibility and traffic disruptions | Traffic problems and conflicts near project locations and haul road | <p>Pipe laying works</p> <ul style="list-style-type: none"> (i) Prepare a pipe laying work implementation plan in each zone separately and undertake the work accordingly; ensure that for each road where the work is being undertaken there is an alternative road for the traffic diversion; take up the work in sequential way so that public inconvenience is minimal; prepare traffic management plans for each section (refer sample in Appendix 5) (ii) Plan the pipe laying work in coordination with the traffic police; provide temporary diversions, where necessary with clear signage and effectively communicate with general public (iii) Avoiding conducting work in all roads in a colony at one go; it will render all roads unusable due to excavations at the same time, creating large scale inconvenience (iv) Undertake the work section wise: a 100m section should be demarcated and barricaded; open up several such sections at a time, but care shall be taken to locate such sections in different zones (v) Confine work areas in the road carriageway to the minimum possible extent; all the activities, including material and waste/surplus soil stocking should be confined to this area. Proper barricading should be provided; avoid material/surplus soil stocking in congested areas – immediately removed from site/ or brought to the as and when required (vi) Limit the width of trench excavation as much as possible by adopting best construction practices; adopt vertical cutting approach with proper shoring and bracing; this is especially to be practiced in narrow roads and deeper excavation; if they deep trenches are excavated with slopes, the roads may render completely unusable during the construction period (vii) Leave spaces for access between mounds of soil to maintain access to the houses / properties; access to any house or property shall not be blocked completely; alternative arrangements, at least to maintain pedestrian access at all times to be provided (viii) Provide pedestrian access in all the locations; provide wooden/metal planks with safety rails over the open trenches at each house to maintain the access. (ix) Inform the affected local population about the work schedule a week before, and a day before to start of work (x) Plan and execute the work in such a way that the period of disturbance/ loss of access is minimum. | Contractor | Project Cost |

| Field | Anticipated Impact | Mitigation Measures | Responsible for Mitigation | Cost and Source of Funds |
|---|--|--|----------------------------|--------------------------|
| | | (xi)Keep the site free from all unnecessary obstructions; (xii)Notify affected public-by-public information notices, providing signboards informing nature and duration of construction works and contact numbers for concerns/complaints. (xiii)At work site, public information/caution boards shall be provided including contact for public complaints Hauling (material, waste/debris and equipment) activities (i) Plan transportation routes so that heavy vehicles do not use narrow local roads, except in the immediate vicinity of delivery sites (ii) Schedule transport and hauling activities during non-peak hours(peak hours 7 to 10 AM and 4 to 7 PM); (iii)Locate entry and exit points in areas where there is low potential for traffic congestion; (iv)Drive vehicles in a considerate manner (v)Notify affected public by public-information notices, providing sign boards informing nature and duration of construction works and contact numbers for concerns/complaints. | | |
| EMP Implementation Training | Irreversible impact to the environment, workers, and community | (i) Project manager and all key workers will be required to undergo training on EMP implementation including spoils/waste management, Standard operating procedures (SOP) for construction works; occupational health and safety (OH and S), core labor laws, applicable environmental laws, etc. | Contractor | Contractor cost |
| Socio-Economic Loss of access to houses and business | Loss of income | (i) Inform all businesses and residents about the nature and duration of any work well in advance so that they can make necessary preparations; (ii) Do not block any access; leave spaces for access between barricades/mounds of excavated soil and other stored materials and machinery, and providing footbridges so that people can crossover open trenches (iii)Barricade the construction area and regulate movement of people and vehicles in the vicinity, and maintain the surroundings safely with proper direction boards, lighting and security personnel – people should feel safe to move around (iv)Control dust generation (v)Immediately consolidate the backfilled soil and restore the road surface; this will also avoid any business loss due to dust and access inconvenience of construction work. (vi)Employee best construction practices, speed up construction work with better equipment, increase workforce, etc., in the areas with predominantly commercial, and with sensitive features like hospitals, and schools; | Contractor | Contractor cost |

| Field | Anticipated Impact | Mitigation Measures | Responsible for Mitigation | Cost and Source of Funds |
|--------------------------------|--|--|----------------------------|--------------------------|
| | | (vii) Consult businesses and institutions regarding operating hours and factoring this in work schedules; and (viii) Provide sign boards for pedestrians to inform nature and duration of construction works and contact numbers for concerns/complaints. | | |
| Socio-Economic – Employment | Generation of temporary employment and increase in local revenue | (i) Employ local labour force as far as possible (ii) Comply with labor laws | Contractor | Contractor cost |
| Occupational Health and Safety | Occupational hazards which can arise during work | (i) Follow all national, state and local labour laws (indicative list is in Appendix 2); (ii) Develop and implement site-specific occupational health and safety (OH and S) Plan which shall include measures such as: (a) safe and documented construction procedures to be followed for all site activities; (b) ensuring all workers are provided with and use personal protective equipment; (c) OH and S Training for all site personnel, (d) excluding public from the work sites; and (e) documentation of work-related accidents; Follow International Standards such as the World Bank Group’s Environment, Health and Safety Guidelines. (iii) Ensure that qualified first-aider is available at all times. Equipped first-aid stations shall be easily accessible throughout the sites; (iv) Secure all installations from unauthorized intrusion and accident risks (v) Provide H and S orientation training to all new workers to ensure that they are apprised of the basic site rules of work at the site, personal protective protection, and preventing injuring to fellow workers; (vi) Provide visitor orientation if visitors to the site can gain access to areas where hazardous conditions or substances may be present. Ensure also that visitor/s do not enter hazard areas unescorted; (vii) Ensure the visibility of workers through their use of high visibility vests and other PPE when working in or walking through heavy equipment operating areas; (viii) Ensure moving equipment is outfitted with audible back-up alarms; (ix) Mark and provide sign boards for hazardous areas such as energized electrical devices and lines, service rooms housing high voltage equipment, and areas for storage and disposal. Signage shall be in accordance with international standards and be well known to, and easily understood by workers, visitors, and the general public as appropriate; and | Contractor | Contractor cost |

| Field | Anticipated Impact | Mitigation Measures | Responsible for Mitigation | Cost and Source of Funds |
|------------------------------|---|--|----------------------------|--------------------------|
| | | <ul style="list-style-type: none"> (x) Disallow worker exposure to noise level greater than 85 dBA for duration of more than 8 hours per day without hearing protection. The use of hearing protection shall be enforced actively. (xi) Provide supplies of potable drinking water; (xii) Provide clean eating areas where workers are not exposed to hazardous or noxious substances | | |
| Community Health and Safety. | Traffic accidents and vehicle collision with pedestrians during material and waste transportation | <ul style="list-style-type: none"> (i) Consult PIU before locating project offices, sheds, and construction plants; (ii) Select a campsite away from residential areas (at least 100 m buffer shall be maintained) or locate the campsite within the existing facilities of City Corporation. (iii) Avoid tree cutting for setting up camp facilities. (iv) Provide a proper fencing/compound wall for campsites. (v) Camp site shall not be located near (100 m) water bodies, flood plains flood prone/low lying areas, or any ecologically, socially, archeologically sensitive areas. (vi) Separate the workers living areas and material storage areas clearly with a fencing and separate entry and exit. (vii) Ensure conditions of liveability at work camps are maintained at the highest standards possible at all times; living quarters and construction camps shall be provided with standard materials (as far as possible to use portable ready to fit-in reusable cabins with proper ventilation); thatched huts, and facilities constructed with materials like GI sheets, tarpaulins, etc., shall not be used as accommodation for workers. (viii) Camp shall be provided with proper drainage, there shall not be any water accumulation. (ix) Provide drinking water, water for other uses, and sanitation facilities for employees; drinking water should be regularly tested to confirm that drinking water standards are met. (x) Prohibit employees from cutting of trees for firewood; contractor should provide cooking fuel (cooking gas); fire wood not allowed (xi) Train employees in the storage and handling of materials which can potentially cause soil contamination (xii) Wastewater from the camps shall be disposed properly either into sewer system; if sewer system is not available, provide on-site sanitation with septic tank and soak pit arrangements (100 m away from surface water body or groundwater well) | Contractor | Contractor cost |

| Field | Anticipated Impact | Mitigation Measures | Responsible for Mitigation | Cost and Source of Funds |
|--------------------------|--|---|----------------------------|--------------------------|
| | | (xiii) Recover used oil and lubricants and reuse or remove from the site; (xiv) Manage solid waste according to the following preference hierarchy: reuse, recycling and disposal to designated areas; provide a compost pit for bio degradable waste, and non-biodegradable / recyclable waste shall be collected and sold in local market (xv) Remove all wreckage, rubbish, or temporary structures which are no longer required; and (xvi) At the completion of work, camp area shall be cleaned and restored to pre-project conditions, and submit report to PIU; PIU to review and approve camp clearance and closure of work site | | |
| Work Camps and worksites | Temporary air and noise pollution from machine operation, water pollution from storage and use of fuels, oils, solvents, and lubricants Unsanitary and poor living conditions for workers | (i) As far as possible located the camp site within the work sites; if any camp to be established outside these, then select a camp site away from residential areas (at least 100 m buffer shall be maintained) (ii) Avoid tree cutting for setting up camp facilities (iii) Ensure that a proper compound wall is provided, and erect a wind/dust screen around (iv) Camp site shall not be located near (100 m) water bodies, flood plains flood prone/low lying areas, or any ecologically, socially, archeologically sensitive areas (v) Separate the workers living areas and material storage areas clearly with a fencing and separate entry and exit (vi) Provide proper temporary accommodation with proper materials, adequate lighting and ventilation, appropriate facilities for winters and summers; ensure conditions of livability at work camps are maintained at the highest standards possible at all times; (vii) Consult PIU before locating project offices, sheds, and construction plants; (viii) Minimize removal of vegetation and disallow cutting of trees (ix) Ensure conditions of livability at work camps are maintained at the highest standards possible at all times; living quarters and construction camps shall be provided with standard materials (as far as possible to use portable ready to fit-in reusable cabins with proper ventilation); thatched huts, and facilities constructed with materials like GI sheets, tarpaulins, etc., shall not be allowed as accommodation for workers (x) Camp shall be provided with proper drainage, there shall not be any water accumulation (xi) Provide drinking water, water for other uses, and sanitation facilities for | Contractor | Contractor cost |

| Field | Anticipated Impact | Mitigation Measures | Responsible for Mitigation | Cost and Source of Funds |
|----------------------------|---|---|----------------------------|--------------------------|
| | | <p>employees</p> <p>(xii) Prohibit employees from cutting of trees for firewood; contractor should be provide proper facilities including cooking fuel (oil or gas; fire wood not allowed)</p> <p>(xiii) Train employees in the storage and handling of materials which can potentially cause soil contamination</p> <p>(xiv) Recover used oil and lubricants and reuse or remove from the site</p> <p>(xv) Manage solid waste according to the following preference hierarchy: reuse, recycling and disposal to designated areas; provide a compost pit for biodegradable waste, and non-biodegradable / recyclable waste shall be collected and sold in local market</p> <p>(xvi) Remove all wreckage, rubbish, or temporary structures which are no longer required</p> <p>(xvii) At the completion of work, camp area shall be cleaned and restored to pre-project conditions, and submit report to PIU; PIU to review and approve camp clearance and closure of work site.</p> | | |
| Post-construction clean-up | Damage due to debris, spoils, excess construction materials | <p>(i) Remove all spoils wreckage, rubbish, or temporary structures (such as buildings, shelters, and latrines) which are no longer required; and</p> <p>(ii) All excavated roads shall be reinstated to original condition.</p> <p>(iii) All disrupted utilities restored</p> <p>(iv) All affected structures compensated</p> <p>(v) The area that previously housed the construction camp is to be checked for spills of substances such as oil, paint, etc. and these shall be cleaned up.</p> <p>(vi) The contractor must arrange the cancellation of all temporary services.</p> <p>(vii) Request PIU to report in writing that worksites and camps have been vacated and restored to pre-project conditions before acceptance of work.</p> | Contractor | Contractor cost |

Table 45: Operation Stage Environmental Impacts and Mitigation Measures

| Field | Anticipated Impact | Mitigation Measures | Responsible for Mitigation | Cost and Source of Funds |
|--|---|--|----------------------------|--------------------------|
| WTP operation | Public health, safety and environmental impacts | (i) Ensure proper knowledge transfer, hands-on training to municipal staff engaged in WTP operation has been provided by Contractor prior to handover of facility (ii) Ensure continuous uninterrupted power supply (iii) Operate and maintain the facility following standard operating procedures of operational manual (iv) Undertake preventive and periodic maintenance activities as required (v) Conduct periodic training to workers (vi) Monitoring water quality and safety in chemical handling | DBOT contractor and PIU | Operating costs |
| Operation and maintenance of distribution system | Blocks, overflows, system malfunction, occupational health and safety | (i) Establish regular maintenance program, including: <ul style="list-style-type: none"> • Regular cleaning of grit chambers and lines to remove grease, grit, and other debris that may lead to water backups. Cleaning should be conducted more frequently for problem areas • Inspection of the condition of storage reservoirs (OHT's) and identifying areas that need repair or maintenance. Items to note may include cracked/deteriorating pipes; leaking joints or seals; frequent line blockages; lines that generally flow at or near capacity; and • Monitoring of water flow to identify potential inflows and outflows (ii) Develop an Emergency Response System for the water system leaks, burst and overflows, etc. (iii) Provide all necessary personnel protection equipment | PIU | Operating costs |

Table 46: Construction Stage Environmental Monitoring Plan

| Monitoring field | Monitoring location | Monitoring parameters | Frequency | Responsibility | Cost and Source of Funds |
|---|---|---|--|--|---|
| Construction disturbances, nuisances, public and worker safety, | All work sites | Implementation of construction stage EMP including dust control, noise control, traffic management, and safety measures. Site inspection checklist to review implementation is appended at Appendix 6 | Weekly during construction | Supervising staff and safeguards specialists of CMSC | Staff and consultant costs are part of incremental administration costs |
| Ambient air quality | 4 locations (locations 50 m downwind direction near WDS work sites in the sub project area); | <ul style="list-style-type: none"> PM₁₀, PM_{2.5} NO₂, SO₂, CO | Once before start of construction and Quarterly (yearly 4-times) during construction (2 year construction period) | Contractor | Cost for implementation of monitoring measures responsibility of contractor (36 samples x Rs.5000/- per sample = Rs.180,000) |
| Ambient noise | 4locations (locations near water distribution station); | <ul style="list-style-type: none"> Day time and night time noise levels | Once before start of construction and Quarterly (yearly 4-times) during construction (2 year construction period) | Contractor | Cost for implementation of monitoring measures responsibility of contractor (36samples x 1500 per sample = 54,000) |
| Surface water quality | 4locations (Lower Camp, Cumbum, Chinnamanur and Theni | <ul style="list-style-type: none"> pH, Oil and grease, Cl, F, NO₃, TC, FC, Hardness, Turbidity BOD, COD, DO, Total Alkalinity | Once before start of construction and Half yearly during construction (2 year construction period) | Contractor | Cost for implementation of monitoring measures responsibility of contractor (20samples x 4000 per sample = 80,000) |

Table 47: Operation Stage Environmental Monitoring Plan

| Monitoring field | Monitoring location | Monitoring parameters | Frequency | Responsibility | Cost and Source of Funds |
|---|--|---|--------------------------------------|--|---------------------------------|
| Monitoring the water quality for IS: 10500 at head works / source before WTP (Water treatment plant). | Inlet of WTP | Turbidity Color Odor pH value @ 25°C Total Dissolved Solids @105°C | Monthly Once | DBOT Contractor will hold the responsibility for 10 years (as per the condition of the contract) and after that the responsibility lies with the PIU | Operating Cost |
| Monitoring the water quality for IS: 10500 at WTP outlet. | Outlet of WTP | Calcium (as Ca) Chlorides (as Cl ⁻) Magnesium (as Mg) Sulphates (as SO ₄ ⁻²) Total Alkalinity (as CaCO ₃) Total Hardness (as CaCO ₃) Iron (as Fe) Free Residual Chlorine, Total Coliform | Monthly Once | | |
| Monitoring the water quality at various points in the distribution system. | Various locations in the distribution system | Residual chlorine | Daily Random sampling month | Madurai Corporation | Operating Cost |
| Noise level monitoring | Near to WTP, Headworks) | Day time and night time noise levels (24 hours) | Monthly Once | | |

A. Implementation Arrangements

228. The Municipal and Water Supply Department (MAWS) acting through TNUIFSL will be the executing agency. A program steering committee, headed by Principal Secretary, MAWS, Government of Tamil Nadu, will provide overall guidance and strategic directions to the program. A program management unit (PMU) for TNUFIP, headed by the Managing Director, TNUIFSL acting as Program Director will be established within TNUIFSL for overall management, planning, implementing, monitoring, reporting, and coordinating TNUFIP. The CMA will act as the Deputy Program Director in the PMU. The project ULBs, represented by respective Municipal Commissioners, will be the implementing agencies for works in cities/towns and will establish program implementing units (PIUs) headed by a municipal engineer as full-time Project Manager. PIUs will comprise of dedicated staff responsible for overseeing implementation of projects on a day-to-day basis. The PIUs will be supported by a contract management and supervision consultant (CMSC) recruited by TNUIFSL. For the institutional capacity, public awareness, and urban governance component, CMA acting through its Commissioner, will establish a PIU and appoint a governance improvement and awareness consultant (GIAC) responsible for supporting these activities. The implementing agency for this subproject is Madurai Municipal Corporation. A Project Implementation Unit (PIU) will be established in Madurai Municipal Corporation headed by City Engineer (Madurai Municipal Corporation) and comprising dedicated full-time staff from engineering and other departments of Madurai Corporation. PIU under the Madurai Municipal Corporation will be responsible for planning, implementation, monitoring and supervision, and coordination of all activities of subproject. A Construction, Management and Supervision Consultant (CMSC) will be appointed to assist PIU in day-to-day implementation of the subproject.

229. **Safeguards Compliance Responsibilities.** Environmental and Social Safeguards (ESS) in the PMU in TNUIFSL will have overall responsibility of safeguard compliance with norms. ESS Managers report to Vice President in the Projects Wing. ESS Managers (TNUIFSL) will report to the Head, Projects Division. The Assistant Executive Engineer in charge of the project, will coordinate safeguard tasks at Madurai Corporation. As expert support is available to Madurai Corporation via CMSC, and the role of Assistant Executive Engineer will be mainly to coordination, overseeing the implementation of safeguard tasks, grievance redress and reporting.

230. **PMU Safeguard Responsibilities.** Key tasks and responsibilities of the ESS Manager (Environment), for this subproject include the following:

DPR finalization and Bidding stage:

- (i) Ensure that all design related measures of the EMP are included designs.
- (ii) Ensure that EMP is included in bidding documents and civil works contracts including requirement for EHS supervisor with the contractor.
- (iii) Ensure that the bid/contract documents include specific provisions requiring contractors to comply with all applicable labour laws and core labour standards.
- (iv) Ensure that staff required for implementation of EMP (EHS officer) is included in the bid requirements.
- (v) Ensure that EMP cost is included in the project cost.
- (vi) Prior to invitation of bids and prior to award of contract, ensure that all clearance/permissions as required for implementation of subproject are in place to the extent possible.

Construction stage:

- (i) Prior to start of construction:
 - Ensure that all necessary clearances/permissions/licences, including that of contractor's are in place prior to start of construction
 - provide oversight on environmental management aspects of subprojects and ensure EMPs are implemented by PIU and contractors
- (ii) Oversee and provide guidance to the PIU to properly carry out the environmental monitoring as per the EMP
- (iii) Oversee grievance redress mechanism to address any grievances brought about in a timely manner; ensure that records are properly maintained.
- (iv) Consolidate quarterly environmental monitoring reports from PIU and submit semi-annual monitoring reports to TNUIFSL.
- (v) Oversee site closures to ensure that all work / facility sites are restored properly prior to issuing work completion certificate to the contractor.

Operation stage:

231. Ensure that operation of water supply system developed under the subproject is in compliance with all government regulations, standards and conditions, such as consent to operate (CTO) for WTP from TNPCB

232. **PIU Safeguard Responsibilities.** Key tasks and responsibilities of the PIU assisted by CMSC for this subproject include the following:

DPR finalization and Bidding stage:

- (i) Include design related measures of the EMP in the project design and DPR
- (ii) Include EMP in the bidding documents and civil works contracts, including requirement of staff (EHS supervisor) with contractor for EMP implementation
- (iii) Provide necessary budget in the project as IEE for EMO Implementation
- (iv) Ensure that the bid/contract documents include specific provisions requiring contractors to comply with all applicable labour laws and core labour standards including:
 - a. Labour welfare measures and provision of amenities
 - b. Prohibition of child labour as defined in national legislation for construction and maintenance activities;
 - c. Equal pay for equal work of equal value regardless of gender, ethnicity, or caste;
 - d. Elimination of forced labour;
 - e. The requirement to disseminate information on sexually transmitted diseases, including HIV/AIDS, to employees and local communities surrounding the project *sites.
- (v) In the pre-bid meeting, provide insight into EMP measures, and overall compliance requirements to the bidders
- (vi) Obtain all clearance/permissions as required for implementation of subproject, prior to invitation of bids and/or prior to award of contract / prior to construction as appropriate

Construction stage:

- (i) Identify regulatory clearance requirements and obtain all necessary clearances prior to start of construction; ensure construction work by contractor is conducted in

compliance with all government rules and regulations including pollution control, labour welfare and safety etc.,

- (ii) Prior to start of construction organize an induction course for the training of contractors, preparing them on EMP implementation, environmental monitoring, and on taking immediate action to remedy unexpected adverse impacts or ineffective mitigation measures found during the course of implementation.
- (iii) Ensure contractor compliance with staff resources as per the IEE/EMP/Bid.
- (iv) Guide contractor on updating EMP / preparing Site Environmental Plan at the start of the project.
- (v) Update IEE and EMP; ensure that IEE reflects the final design being implemented by contractor.
- (vi) Conduct public consultation and information disclosure as necessary.
- (vii) Take necessary action for obtaining rights of way.
- (viii) Supervise day-to-day EMP implementation on site by contractor, including the environmental monitoring plan;
- (ix) Supervise ambient environmental monitoring by contractors.
- (x) Take corrective actions when necessary to ensure no environmental impacts.
- (xi) Submit quarterly environmental monitoring reports to PMU.
- (xii) Conduct continuous public consultation and awareness.
- (xiii) Address any grievances brought about through the grievance redress mechanism in a timely manner as per the EMP.
- (xiv) Monitor Contractor's compliance with the measures set forth in the EMP and any corrective or preventative actions set forth in a safeguards monitoring report that the PMU will prepare from time to time;
- (xv) Implement corrective or preventative actions in case of non-compliance or new/unanticipated impacts;
- (xvi) Inform PMU promptly in case if any significant impacts surfaces, which were not identified in the IEE and develop necessary corrective actions as necessary and ensure implementation by the contractors; include all such impacts and suggested actions in the Quarterly Environmental Monitoring Reports
- (xvii) Implementation grievance redress system, and undertake appropriate actions to redress the complaints; ensure that complaints/grievances are addressed in a timely manner and resolutions are properly documented;
- (xviii) Review and approve monthly progress reports submitted by Contractor on EMP compliance,
- (xix) Prepare quarterly environmental monitoring reports and submit to PMU /TNUIFSL
- (xx) Provide any assistance in environmental safeguard related tasks as required by PMU to ensure compliance and reporting to ADB.

Operation stage:

- (i) Obtain all clearances as required for operation of project prior to operation, such as consent to operate (CTO) for WTP from TNPCB
- (i) Conduct environmental management and monitoring activities as per the EMP
- (ii) Ensure that conveyance system constructed and operated with all necessary clearances and approvals, and compliance with standards and conditions.

233. **Contractor's Responsibilities:**

Bidding stage:

- (i) Understand the EMP requirements and allocate necessary resources (budget, staff, etc.,)
- (ii) Understand the regulatory compliance requirements related to labour welfare, safety, environment etc.,

Construction stage:

- (i) Mobilize EHS Supervisor prior to start of work.
- (ii) Prepare SEMP and submit to PIU in Madurai Municipal Corporation.
- (iii) Ensure that all regulatory clearances (both project related and contractor related) are in place prior start of the construction work.
- (iv) Confirm with PIU availability of rights of way at all project sites prior to start of work.
- (v) Prepare and submit:
 - a. Construction waste management (CWM) plan (sample is in **Appendix 4**)
 - b. Traffic management (TM) plan (sample is **Appendix 5**)
- (vi) Implement the mitigation measures as per the EMP including CWM and TM Plans
- (vii) Follow the EMP measures/guidelines for establishment of temporary construction camps, construction waste disposal sites, and material borrow areas, etc.,
- (viii) Implement EMP and ensure compliance with all the mitigation and enhancement measures
- (ix) Conduct environmental monitoring (air, noise, water etc.,) as per the EMP
- (x) Undertake immediate action as suggested by PIU to remedy unexpected adverse impacts or ineffective mitigation measures found during the course of implementation.
- (xi) Submit monthly progress reports on EMP implementation to PIU.
- (xii) Act promptly on public complaints and grievances related to construction work and redress in a timely manner in coordination with PIU and CMSC.
- (xiii) Comply with applicable government rules and regulations

B. Training Needs

234. **Table 48** presents the outline of capacity building program to ensure EMP implementation. These capacity building and trainings will be conducted at the offices of PMU and PIU by the environmental safeguards specialist of PMU/PIU and their consultants, which are part of project implementation set-up, and therefore no separate or additional costs are envisaged. Adequate costs are already considered in project's capacity building program. The detailed program and specific modules will be customized for the available skill set after assessing the capabilities of the target participants and the requirements of the project by the PMU.

Table 48: Outline Capacity Building Program on EMP Implementation

| Description | Target Participants and Venue | Cost and Source of Funds |
|--|---|---|
| <p>1. Introduction and Sensitization to Environmental Issues (1 day)</p> <ul style="list-style-type: none"> - Safeguards Policy Statement - Government of India and Tamil Nadu applicable safeguard laws, regulations and policies including but not limited to core labor standards, OH and S, etc. - Incorporation of EMP into the project design and contracts - Monitoring, reporting and corrective action planning | <p>All staff and consultants involved in the project</p> <p>At PMU (combined program for all PIU)</p> | <p>Included in the overall program cost</p> |
| <p>2. EMP implementation (1/2 day)</p> <ul style="list-style-type: none"> - EMP mitigation and monitoring measures - Roles and responsibilities - Public relations, - Consultations - Grievance redress - Monitoring and corrective action planning - Reporting and disclosure - Construction site standard operating procedures (SOP) - Chance find (archeological) protocol - AC pipe protocol - Traffic management plan - Waste management plan - Site clean-up and restoration | <p>All PIU staff, contractor staff and consultants involved in the subproject</p> <p>At PIU</p> | <p>To be conducted by CMSC at the PIU office; part of project implementation cost</p> |
| <p>3. Contractors Orientation to Workers (1/2 day)</p> <ul style="list-style-type: none"> - Environment, health and safety in project construction | <p>Before start of work, regular briefing is done once in every month.</p> <p>Daily briefing on safety prior to start of work</p> <p>All workers (including unskilled laborers)</p> | <p>Contractors' EHS officer to conduct program, with guidance of CMSC</p> |

C. Monitoring and Reporting

235. Immediately after mobilization and prior to commencement of the works, the contractor will submit a compliance report to PIU in Madurai Municipal Corporation that all identified pre-construction mitigation measures as detailed in the EMP are undertaken. Baseline Environmental monitoring as indicated in the construction stage environmental monitoring plan should be conducted and the analysis of the outcome should be shared in the compliance report. Contractor should confirm that the staff for EMP implementation (EHS supervisor) is mobilized. PIU will review, and approve the report and permit commencement of works.

236. During construction, results from internal monitoring by the contractor will be reflected in their monthly EMP implementation reports to the PIU. CMSC will monitor, review and advise contractors for corrective actions if necessary. Quarterly Environmental Monitoring Report (QEMR) summarizing compliance and corrective measures, if any, taken will be prepared by CMSC team at PIU and submitted to PMU (Report format is at **Appendix**

7). During operation, PIU will conduct management and monitoring actions as per the operation stage EMP, and submit to PMU annual report.

237. Based on PIU Quarterly Environmental Monitoring Reports (QEMR) and oversight visits to subproject work sites, PMU will submit semi-annual Environmental Monitoring Report (EMR). Once concurrence from the ADB is received the report will be disclosed on TNUIFSL and Madurai Municipal Corporation websites.

238. ADB will review project performance against the TNUFIP commitments as agreed in the legal documents (loan and project agreements etc.). The extent of ADB's monitoring and supervision activities will be commensurate with the project's risks and impacts. Monitoring and supervising of social and environmental safeguards will be integrated into the project performance management system.

D. EMP Implementation Cost

239. Most of the mitigation measures require the contractors to adopt good site/engineering practices, which should be part of their normal procedures, so there are unlikely to be major costs associated with compliance. The costs, which are specific to EMP implementation and are not covered elsewhere in the projects, are given below.

Table 49: Cost Estimates to Implement the EMP

| S. No. | Particulars | Stages | Unit | Total Number | Rate (INR) | Cost (INR) | Costs Covered By |
|--------------------------------|---|--------------|------------|--------------|------------|-------------------|------------------------|
| A. Implementation staff | | | | | | | |
| 1 | EHS Supervisor | Construction | per month | 24 | 35,000 | 8,40,000/- | Civil works contractor |
| Subtotal (A) | | | | | | 8,40,000/- | |
| B. Mitigation Measures | | | | | | | |
| 1 | Provision for tree cutting and compensatory plantation measures (1:10 ratio replantation) | Construction | Per tree | 3000 | 1000 | 30,00,000 | Project costs (PIU) |
| 2 | Preparation of plans traffic management plan, waste (spoils) management plan etc.), traffic management at work sites (Pavement Markings, Channelizing Devices, Arrow Panels and Warning Lights) | Construction | Lump sum | - | - | 6,00,000 | Civil works contractor |
| Subtotal (B) | | | | | | 36,00,000 | |
| C. Monitoring Measures | | | | | | | |
| 1 | Air quality monitoring | Construction | per sample | 24 | 3,500 | 84,000 | Civil works contractor |
| 2 | Noise levels | Construction | Per | 40 | 1,500 | 60,000 | |

| S. No. | Particulars | Stages | Unit | Total Number | Rate (INR) | Cost (INR) | Costs Covered By |
|-----------|--|-------------------------------|------------|--------------|------------|--------------------|---------------------|
| | monitoring | | sample | | | | |
| 3 | Water monitoring | Construction | Per sample | 8 | 4,000 | 32,000 | |
| | Subtotal (C) | | | | | 1,76,000/- | |
| D. | Capacity Building | | | | | | |
| 1. | Training on EMP implementation | Pre-construction | | | | - | Project costs (PIU) |
| 2. | Contractors Orientation to Workers on EMP implementation | Prior to dispatch to worksite | | | | - | |
| | Subtotal (D) | | | | | | |
| | | | | | | | |
| | Total (A+B+C+D) | | | | INR | 46,16,000/- | |

IX.

X. CONCLUSION AND RECOMMENDATIONS

240. The process described in this document has been assessed for the environmental impacts of all elements of the proposed Water supply System for Madurai Municipal Corporation. All potential impacts were identified in relation to Designing, 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 pertaining to the project design or location were not significant. Mitigation measures have been developed to reduce all negative impacts to acceptable levels. These were discussed with specialists responsible for the engineering aspects, and as a result of significant measures have already been included in the designs for the infrastructure.

241. A proposed 125 MLD Water Treatment Plant will be installed and the treated water of quantity 125 MLD will be utilized / managed to fulfill the intermediate demand gap of Madurai Municipal Corporation.

242. The project will be carried out in the properties of the local government and the access to the project location will be made through public rights-of-way and existing roads. Hence, the head works site is the only land need to be procured, this would be for an extent of 2 acres, for which consent from the owner of the land has been obtained. Land acquisition by Madurai Corporation is under progress and the details of the land acquisition is covered under RP.

243. Except pipe laying works, all other construction activities will be confined to the selected sites, and the interference with the general public and community around is minimal. There will be temporary negative impacts, arising mainly from construction dust and noise, hauling of construction material, waste and equipment on local roads (traffic, dust, safety etc.), mining of construction material, occupation health and safety aspects. Pipeline works will be conducted along edge of public roads in an urban area congested with people, activities and traffic, subproject is likely to have significant impacts during construction. Impacts mainly arise from the construction dust and noise; from the disturbance of residents, businesses, traffic by the construction work, safety risk to workers, public and nearby buildings due to deep trench excavations, especially in narrow roads, dust, 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 EMP.

244. Once the new system is operating, the facilities will operate with routine maintenance, which should not affect the environment. Improved system operation will comply with the O & M manual and standard operating procedures to be developed for all the activities. Pre audit will be carried out prior to operation of the scheme.

245. Mitigation will be assured by a program of environmental monitoring conducted during construction and operation to ensure that all measures are implemented, and to determine whether the environment is protected as intended. This will include observations on- and off-site, document checks, and interviews with workers and beneficiaries, and any requirements for remedial action will be reported to the PMU. Mitigation and monitoring measures, along with the project agency responsible for such actions, which would form part of the Environmental Management Plan.

246. Stakeholders were involved in developing the IEE through face-to-face discussions. Views expressed by the stakeholders were incorporated into the IEE and the planning and development of the project. The IEE will be made available at public locations and will be disclosed to a wider audience via Madurai Municipal Corporation and ADB websites. The consultation process will be continued during project implementation, as required, to ensure that stakeholders are engaged in the project and have the opportunity to participate in its development and implementation.

247. The project's grievance redress mechanism will provide the citizens with a platform to redress their grievances, and describes the informal and formal channels, time frame, and mechanisms for resolving complaints about environmental performance.

248. The EMP will assist the project agencies and contractor in mitigating the environmental impacts, and guide them in the environmentally sound execution of the proposed project. A copy of the updated EMP/ SEMP shall be kept on-site during the construction period at all times. The EMP shall be made binding on all contractors operating on the site, to ensure compliance to the conditions set out in this document.

249. The citizens of the sub projects area of Madurai City Municipal Corporation is the beneficiaries of this subproject. The new water supply system will provide safe drinking water of acceptable standard for the public which will improve the over-all public health in the project area. Diseases due to poor water quality, such as Cholera, diarrhoea and dysentery will be prevented so people should spend less on healthcare and lose fewer working days due to illness, so their economic status should also improve, as well as their overall health.

250. Therefore, as per ADB SPS, the project is classified as Environmental Category 'B' and does not require further Environmental Impact Assessment. Madurai Municipal Corporation shall update this IEE during the implementation phase to reflect any changes, amendments.

Appendix 1: REA Checklist

Water supply

- a) Instructions:
- This checklist is to be prepared to support the environmental classification of a project. It is to be attached to the environmental categorization form that is to be prepared and submitted to the Chief Compliance Officer of the Regional and Sustainable Development Department.
 - This checklist is to be completed with the assistance of an Environment Specialist in a Regional Department.
 - This checklist for cubic feet per second on environmental issues and concerns. To ensure that social dimensions are adequately considered, refer also to ADB checklists and handbooks on (i) involuntary resettlement, (ii) indigenous peoples planning, (iii) poverty reduction, (iv) participation, and (v) gender and development.
 - Answer the questions assuming the “without mitigation” case. The purpose is to identify potential impacts. Use the “remarks” section to discuss any anticipated mitigation measures.

Country/Project Title: India / Tamil Nadu Urban Flagship Investment Program– Providing Dedicated Water Supply Scheme For Madurai Corporation From Mullai Periyar At Lower Camp

Sector Division: Urban Development

| Screening Questions | Yes | No | Remarks |
|--|---|-------------------------------------|---|
| A. Project Siting | | | |
| Is the project area | | | |
| • Densely populated? | <input checked="" type="checkbox"/> Yes | <input type="checkbox"/> | Core Madurai city areas are very densely populated. Added areas are comparatively less dense. The entire core Maduraicity has already been provided with water supply and sewerage facilities. It is proposed to expand water supply facilities. Accordingly providing water in some, parts of added areas are in various stages of implementation. As part of the water supply proposal, now it is proposed to augment the source of water supply through pumping based bulk source abstraction, treatment, transmission, interim storage and distribution to sub-project covered areas. |
| • Heavy with development activities? | <input checked="" type="checkbox"/> | <input type="checkbox"/> | It is a developing area; urban expansion is considerable |
| • Adjacent to or within any environmentally sensitive areas? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| • Cultural heritage site | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| • Protected Area | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| • Wetland | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| • Mangrove | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| • Estuarine | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| • Buffer zone of protected area | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| • Special area for protecting biodiversity | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| • Bay | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| B. Potential Environmental Impacts | | | |
| Will the Project cause... | | | |

| Screening Questions | Yes | No | Remarks |
|---|--------------------------|-------------------------------------|--|
| ▪ Pollution of raw water supply from upstream waste water discharge from communities, industries, agriculture and soil erosion runoff | <input type="checkbox"/> | <input checked="" type="checkbox"/> | The intake source is located in the upstream of the Mullaipariyar river; there are no settlements, Industries, agriculture activities. However, soil erosion is likely, but it is a rare occurrence. |
| ▪ Impairment of historical/cultural monuments/areas and loss/damage to these sites? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | No historical or cultural sites in the proposed project area |
| ▪ Hazard of land subsidence caused by excessive ground water pumping? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Ground water will not be extracted for providing water supply |
| ▪ Social conflicts arising from displacement of communities? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| ▪ Conflicts in abstraction of raw water for water supply with other beneficial water uses for surface and ground waters? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | There will not be any conflicts. 200 Cusecs has been allotted for drinking water to the Madurai Municipal Corporation in the allotted quantity only 50 Cusecs will be drawn for above scheme. Remaining 150 Cusecs will be in the river flow and while implementation of Mullai Periyar Scheme will not affect the irrigation and drinking water facilities. |
| ▪ Unsatisfactory raw water supply (e.g. excessive pathogens or mineral constituents)? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| ▪ Delivery of unsafe water to distribution system? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Only liquid chlorine will be used for disinfection in the water treatment plant. The water treatment plant will ensure all quality criteria set by CPCB for drinking water standards. |
| ▪ Inadequate protection of intake works or wells, leading to pollution of water supply? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| ▪ Over pumping of ground water, leading to salinization and ground subsidence? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| ▪ Excessive algal growth in storage reservoir? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| ▪ increase in production of sewage beyond capabilities of community facilities? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| ▪ inadequate disposal of sludge from water treatment plants? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| ▪ inadequate buffer zone around pumping and treatment plants to alleviate noise and other possible nuisances and protect facilities? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| ▪ impairments associated with transmission lines and access roads? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |

| Screening Questions | Yes | No | Remarks |
|--|-------------------------------------|-------------------------------------|--|
| ▪ health hazards arising from inadequate design of facilities for receiving, storing, and handling of chlorine and other hazardous chemicals. | <input type="checkbox"/> | <input checked="" type="checkbox"/> | All the norms and guidelines for operation and maintenance of the treatment plan, including handling chlorine will be followed. Guidelines for handling and chlorine is added as a part of this IEE. Chlorine dosing will be done through chlorinator and chlorine safety measures and facilities are proposed to be implemented as part of the subproject as per MSIH rules, 1989 and its amendment in 2010. |
| ▪ health and safety hazards to workers from the management of chlorine used for disinfection and other contaminants? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Operation and Maintenance recommended by the manufacturers, and the existing norms and guidelines for ensuring the safety of workers will be followed. |
| ▪ dislocation or involuntary resettlement of people | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| ▪ social conflicts between construction workers from other areas and community workers? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| ▪ noise and dust from construction activities? | <input checked="" type="checkbox"/> | <input type="checkbox"/> | Noise and dust may occur during construction period. But it is only temporary. Suitable mitigation measures will be adopted to contain noise and dust pollution |
| ▪ increased road traffic due to interference of construction activities? | <input checked="" type="checkbox"/> | <input type="checkbox"/> | Increase in road traffic may occur in some areas. But it is only temporary in nature. |
| ▪ continuing soil erosion/silt runoff from construction operations? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| ▪ delivery of unsafe water due to poor O&M treatment processes (especially mud accumulations in filters) and inadequate chlorination due to lack of adequate monitoring of chlorine residuals in distribution systems? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| ▪ delivery of water to distribution system, which is corrosive due to inadequate attention to feeding of corrective chemicals? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| ▪ Accidental leakage of chlorine gas? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not envisaged, chlorine gas shall not be used in the WTP. |
| ▪ Excessive abstraction of water affecting downstream water users? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| ▪ competing uses of water? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable |
| ▪ increased sewage flow due to increased water supply | <input checked="" type="checkbox"/> | <input type="checkbox"/> | Due to the water supply, there is possibility for the increase sewage flow. However, the existing UGSS shall cater the increased sewage flow |
| ▪ increased volume of sullage (wastewater from cooking and washing) and sludge from wastewater treatment plant | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Not Applicable, the WTP shall be designed with appropriate technology to minimize the sludge generation. |

Climate Change and Disaster Risk Questions

| Climate Change and Disaster Risk Questions The following questions are not for environmental categorization. They are included in this checklist to help identify potential climate and disaster risks. | Yes | No | Remarks |
|---|--------------------------|-------------------------------------|--------------------|
| Is the Project area subject to hazards such as earthquakes, floods, landslides, tropical cyclone winds, storm surges, tsunami or volcanic eruptions and climate changes? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Does not envisaged |
| Could changes in temperature, precipitation, or extreme events patterns over the Project lifespan affect technical or financial sustainability (e.g., changes in rainfall patterns disrupt reliability of water supply; sea level rise creates salinity intrusion into proposed water supply source)? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Does not envisaged |
| Are there any demographic or socio-economic aspects of the Project area that are already vulnerable (e.g., high incidence of marginalized populations, rural-urban migrants, illegal settlements, ethnic minorities, women or children)? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Does not envisaged |
| Could the Project potentially increase the climate or disaster vulnerability of the surrounding area (e.g., by using water from a vulnerable source that is relied upon by many user groups, or encouraging settlement in earthquake zones)? | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Does not envisaged |

Appendix 2: Salient Features of Major Labor Laws Applicable to Establishments Engaged in Construction of Civil Works

(i) Workmen Compensation Act, 1923 - The Act provides for compensation in case of injury by accident arising out of and during the course of employment.

(ii) Payment of Gratuity Act, 1972 - Gratuity is payable to an employee under the Act on satisfaction of certain conditions on separation if an employee has completed 5 years' service or more or on death at the rate of 15 days wages for every completed year of service. The Act is applicable to all establishments employing 10 or more employees.

(iii) Employees' PF and Miscellaneous Provisions Act, 1952 - The Act provides for monthly contributions by the employer plus workers @10 % or 8.33 %. The benefits payable under the Act are: (a) Pension or family pension on retirement or death as the case may be; (b) deposit linked insurance on the death in harness of the worker; (c) payment of PF accumulation on retirement/death etc.

(iv) Maternity Benefit Act, 1951 - The Act provides for leave and some other benefits to women employees in case of confinement or miscarriage etc.

(v) Contract Labour (Regulation and Abolition) Act, 1970 - The Act provides for certain welfare measures to be provided by the Contractor to contract labor and in case the Contractor fails to provide, the same are required to be provided by the Principal Employer by Law. The principal employer is required to take Certificate of Registration and the Contractor is required to take a License from the designated Officer. The Act is applicable to the establishments or Contractor of principal employer if they employ 20 or more contract labor.

(vi) Minimum Wages Act, 1948 - The employer is supposed to pay not less than the Minimum Wages fixed by appropriate Government as per provisions of the Act if the employment is a scheduled employment. Construction of Buildings, Roads, Runways are scheduled employment.

(vii) Payment of Wages Act, 1936 - It lays down as to by what date the wages are to be paid, when it will be paid and what deductions can be made from the wages of the workers.

(viii) Equal Remuneration Act, 1979 - The Act provides for payment of equal wages for work of equal nature to Male and Female workers and not for making discrimination against Female employees in the matters of transfers, training and promotions etc.

(ix) Payment of Bonus Act, 1965 - The Act is applicable to all establishments employing 20 or more workmen. The Act provides for payments of annual bonus subject to a minimum of 8.33 % of wages and maximum of 20 % of wages to employees drawing Rs. 3,500/- per month or less. The bonus to be paid to employees getting Rs. 2,500/- per month or above up to Rs.3,500/- per month shall be worked out by taking wages as Rs.2,500/- per month only. The Act does not apply to certain establishments. The newly set up establishments are exempted for five years in certain circumstances. Some of the State Governments have reduced the employment size from 20 to 10 for the purpose of applicability of the Act.

(x) Industrial Disputes Act, 1947 - The Act lays down the machinery and procedure for resolution of industrial disputes, in what situations a strike or lock-out becomes illegal and what are the requirements for laying off or retrenching the employees or closing down the establishment.

(xi) Industrial Employment (Standing Orders) Act, 1946 - It is applicable to all establishments employing 100 or more workmen (employment size reduced by some of the States and Central Government to 50). The Act provides for laying down rules governing the

conditions of employment by the employer on matters provided in the Act and get the same certified by the designated Authority.

(xii) Trade Unions Act, 1926 - The Act lays down the procedure for registration of trade unions of workmen and employees. The trade unions registered under the Act have been given certain immunities from civil and criminal liabilities.

(xiii) Child Labor (Prohibition and Regulation) Act, 1986 - The Act prohibits employment of children below 14 years of age in certain occupations and processes and provides for regulation of employment of children in all other occupations and processes. Employment of child labor is prohibited in Building and Construction Industry.

(xiv) Inter-State Migrant Workmen's (Regulation of Employment and Conditions of Service) Act, 1979 - The Act is applicable to an establishment which employs 5 or more inter-state migrant workmen through an intermediary (who has recruited workmen in one state for employment in the establishment situated in another state). The inter-state migrant workmen, in an establishment to which this Act becomes applicable, are required to be provided certain facilities such as housing, medical aid, traveling expenses from home up to the establishment and back, etc

(xv) The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 and the Cess Act of 1996 - All the establishments who carry on any building or other construction work and employ 10 or more workers are covered under this Act. All such establishments are required to pay Cess at rate not exceeding 2% of the cost of construction as may be notified by the Government. The employer of the establishment is required to provide safety measures at the building or construction work and other welfare measures, such as canteens, first-aid facilities, ambulance, housing accommodation for workers near the workplace etc. The employer to whom the Act applies has to obtain a registration certificate from the Registering Officer appointed by the Government.

Appendix 3: Sample Grievance Registration Form

(To be available in Tamil and English)

The _____ Project welcomes complaints, suggestions, queries, and comments regarding project implementation. We encourage persons with grievance to provide their name and contact information to enable us to get in touch with you for clarification and feedback.

Should you choose to include your personal details but want that information to remain confidential, please inform us by writing/typing ***(CONFIDENTIAL)*** above your name. Thank you.

| | | | | | |
|---|-----------------------|--------------|--------------------|-----|-----|
| Date | Place of registration | Project Town | | | |
| | | Project: | | | |
| Contact information/personal details | | | | | |
| Name | | Gender | * Male * Female | Age | 34. |
| Home address | | | | | |
| Place | | | | | |
| Phone no. | | | | | |
| E-mail | | | | | |
| Complaint/suggestion/comment/question Please provide the details (who, what, where, and how) of your grievance below: | | | | | |
| If included as attachment/note/letter, please tick here: | | | | | |
| How do you want us to reach you for feedback or update on your comment/grievance? | | | | | |

FOR OFFICIAL USE ONLY

| | |
|--|-----------|
| Registered by: (Name of official registering grievance) | |
| Mode of communication: Note/letter E-mail Verbal/telephonic | |
| Reviewed by: (Names/positions of officials reviewing grievance) | |
| Action taken: | |
| Whether action taken disclosed: | Yes No |
| Means of disclosure: | |

Appendix 4: Sample Outline Spoils (Construction Waste) Management Plan

- The Spoil Management Plan should be site specific and be part of the monthly Construction Management Plan.
- The contractor, in consultation with the PIU, has to find out appropriate location/s for the disposal of the excess soil generated. The spoils should be deposited only at these sites.
- Further precautions need to be taken in case of the contaminated spoils
- The vehicle carrying the spoil should be covered properly.
- The spoils generating from each site should be removed on the same day or immediately after the work is complete. The site / road should be restored to the original condition.

I. Spoils information

The spoil information contains the details like a) The type / material, b) Potential contamination by that type, c) Expected volume (site / component specific), d) Spoil Classification etc.

II. Spoils management

The Spoil Management section gives the details of a) Transportation of spoil b) disposal site details c) Precautions taken d) Volume of contaminated spoil, if present, d) Suggested reuse of disposal of the spoil.

III. Documentation

The volume of spoil generated (site specific, date wise), site disposed, reuse / disposal details should be documented properly.

Appendix 5: Sample Outline Traffic Management Plan

A. Principles for TMP around the Water Supply Scheme Implementation Sites

1. One of the prime objectives of this TMP is to ensure the safety of all the road users along the work zone, and to address the following issues:
 - (i) the safety of pedestrians, bicyclists, and motorists travelling through the construction zone;
 - (ii) protection of work crews from hazards associated with moving traffic;
 - (iii) mitigation of the adverse impact on road capacity and delays to the road users;
 - (iv) maintenance of access to adjoining properties; and
 - (v) addressing issues that may delay the project.

B. Operating Policies for TMP

2. The following principles will help promote safe and efficient movement for all road users (motorists, bicyclists, and pedestrians, including persons with disabilities) through and around work zones while reasonably protecting workers and equipment.
 - (i) Make traffic safety and temporary traffic control an integral and high-priority element of project from planning through design, construction, and maintenance.
 - (ii) Inhibit traffic movement as little as possible.
 - (iii) Provide clear and positive guidance to drivers, bicyclists, and pedestrians as they approach and travel through the temporary traffic control zone.
 - (iv) Inspect traffic control elements routinely, both day and night, and make modifications when necessary.
 - (v) Pay increased attention to roadside safety in the vicinity of temporary traffic control zones.
 - (vi) Train all persons that select, place, and maintain temporary traffic control devices.
 - (vii) Keep the public well informed.
 - (viii) Make appropriate accommodation for abutting property owners, residents, businesses, emergency services, railroads, commercial vehicles, and transit operations.
3. **Figure** illustrates the operating policy for TMP for the construction of water pipes along various types of roads.

C. Analyze the impact due to street closure

4. Apart from the capacity analysis, a final decision to close a particular street and divert the traffic should involve the following steps:
 - (i) Approval from the Greater Corporation/ Highways/ Public Works Department (PWD) to use the local streets as detours;
 - (ii) Consultation with businesses, community members, traffic police, PWD, etc, regarding the mitigation measures necessary at the detours where the road is diverted during the construction;
 - (iii) Determining of the maximum number of days allowed for road closure, and incorporation of such provisions into the contract documents;
 - (iv) Determining if additional traffic control or temporary improvements are needed along the detour route;

- (v) Considering how access will be provided to the worksite;
- (vi) Contacting emergency service, school officials, and transit authorities to determine if there are impacts to their operations; and
- (vii) Developing a notification program to the public so that the closure is not a surprise. As part of this program, the public should be advised of alternate routes that commuters can take or will have to take as result of the traffic diversion.

5. If full road-closure of certain streets within the area is not feasible due to inadequate capacity of the detour street or public opposition, the full closure can be restricted to weekends with the construction commencing on Saturday night and ending on Monday morning prior to the morning peak period.

Figure: Policy Steps for the TMP

| | |
|--------------------------------|---|
| Review | <ul style="list-style-type: none"> • Review construction schedule and methods |
| Traffic Re-Circulation | <ul style="list-style-type: none"> • Identify initial traffic recirculation and control policy |
| Traffic Diversions | <ul style="list-style-type: none"> • Identify routes for traffic diversions • Analyse adverse impact and mitigation at the detours |
| Full Road Closures | <ul style="list-style-type: none"> • Begin community consultation for consensus • Finalise or determine alternate detours |
| Temporary parking | <ul style="list-style-type: none"> • Identify temporary parking (on and off-street) • Discuss with CMC, owner, community for use |
| Police Coordination | <ul style="list-style-type: none"> • Coordinate with the Traffic Police to enforce traffic and diversions |
| Install control devices | <ul style="list-style-type: none"> • Install traffic control devices (traffic cones, signs, lightings, etc) |
| Awareness | <ul style="list-style-type: none"> • Conduct campaigns, publicity, and notify public about street closure |
| Public Redress | <ul style="list-style-type: none"> • Develop a mechanism to address public grievances regarding disruptions (traffic, utilities, and diversions) |

D. Public awareness and notifications

6. As per discussions in the previous sections, there will be travel delays during the constructions, as is the case with most construction projects, albeit on a reduced scale if utilities and traffic management are properly coordinated. There are additional grounds for travel delays in the area, as most of the streets lack sufficient capacity to accommodate additional traffic from diverted traffic as a result of street closures to accommodate the works.

7. The awareness campaign and the prior notification for the public will be a continuous activity which the project will carry out to compensate for the above delays and minimize public claims as result of these problems. These activities will take place sufficiently in

advance of the time when the roadblocks or traffic diversions take place at the particular streets. The reason for this is to allow sufficient time for the public and residents to understand the changes to their travel plans. The project will notify the public about the roadblocks and traffic diversion through public notices, ward level meetings and city level meeting with the elected representatives.

8. The PIU will also conduct an awareness campaign to educate the public about the following issues:

- (i) Traffic control devices in place at the work zones (signs, traffic cones, barriers, etc.);
- (ii) Defensive driving behaviour along the work zones; and
- (iii) Reduced speeds enforced at the work zones and traffic diversions.

9. It may be necessary to conduct the awareness programs/campaigns on road safety during construction.

10. The campaign will cater to all types of target groups i.e. children, adults, and drivers. Therefore, these campaigns will be conducted in schools and community centres. In addition, the project will publish a brochure for public information. These brochures will be widely circulated around the area and will also be available at the PIU, and the contractor's site office. The text of the brochure should be concise to be effective, with a lot of graphics. It will serve the following purpose:

- (i) Explain why the brochure was prepared, along with a brief description of the project;
- (ii) Advise the public to expect the unexpected;
- (iii) Educate the public about the various traffic control devices and safety measures adopted at the work zones;
- (iv) Educate the public about the safe road user behaviour to emulate at the work zones;
- (v) Tell the public how to stay informed or where to inquire about road safety issues at the work zones (name, telephone, mobile number of the contact person; and
- (vi) Indicate the office hours of relevant offices.

E. Install traffic control devices at the work zones and traffic diversion routes

11. The purpose of installing traffic control devices at the work zones is to delineate these areas to warn, inform, and direct the road users about a hazard ahead, and to protect them as well as the workers. As proper delineation is a key to achieve the above objective, it is important to install good traffic signs at the work zones. The following traffic control devices are used in work zones:

- Signs
- Pavement Markings
- Channelizing Devices
- Arrow Panels
- Warning Lights

12. Procedures for installing traffic control devices at any work zone vary, depending on road configuration, location of the work, construction activity, duration, traffic speed and volume, and pedestrian traffic. Work will take place along major roads, and the minor internal roads. As such, the traffic volume and road geometry vary. The main roads carry considerable traffic; internal roads in the new city areas are wide but in old city roads very narrow and carry considerable traffic. However, regardless of where the construction takes place, all the work zones should be cordoned off, and traffic shifted away at least with traffic cones, barricades, and temporary signs (temporary “STOP” and “GO”).

13. Illustrates a typical set-up for installing traffic control devices at the work zone of the area, depending on the location of work on the road way, and road geometrics:

- Work on shoulder or parking lane
- Shoulder or parking lane closed on divided road
- Work in Travel lane
- Lane closure on road with low volume
- Street closure with detour

14. The work zone should take into consideration the space required for a buffer zone between the workers and the traffic (lateral and longitudinal) and the transition space required for delineation, as applicable. For the works, a 30 cm clearance between the traffic and the temporary STOP and GO signs should be provided. In addition, at least 60 cm is necessary to install the temporary traffic signs and cones.

15. Traffic police should regulate traffic away from the work zone and enforce the traffic diversion result from full street closure in certain areas during construction. Flaggers/ personnel should be equipped with reflective jackets at all times and have traffic control batons (preferably the LED type) for regulating the traffic during night time.

16. In addition to the delineation devices, all the construction workers should wear fluorescent safety vests and helmets in order to be visible to the motorists at all times. There should be provision for lighting beacons and illumination for night constructions.

Appendix 6: Sample Environmental Site Inspection Report

Project Name: Providing comprehensive Water Supply Scheme to Madurai City
 Contract Number: _____

NAME: _____ DATE: _____
 TITLE: _____ DMA: _____
 LOCATION: _____ GROUP: _____

WEATHER: _____

| | | |
|------------------------------|-------------------|--|
| Project Activity Stage | Survey | |
| | Design | |
| | Implementation | |
| | Pre-Commissioning | |
| | Guarantee Period | |

| Monitoring Items | Compliance |
|--|------------|
| Compliance marked as Yes / No / Not applicable (NA) / Partially Implemented (PI) | |
| EHS supervisor appointed by contractor and available on site | |
| Construction site management plan (spoils, safety, schedule, equipment etc.) prepared | |
| Traffic management plan prepared | |
| Dust is under control | |
| Excavated soil properly placed within minimum space | |
| Construction area is confined; no traffic/pedestrian entry observed | |
| Surplus soil/debris/waste is disposed without delay | |
| Construction material (sand/gravel/aggregate) brought to site as and when required only | |
| Tarpaulins used to cover sand and other loose material when transported by vehicles | |
| After unloading, wheels and undercarriage of vehicles cleaned prior to leaving the site | |
| No AC pipes disturbed/removed during excavation | |
| No chance finds encountered during excavation | |
| Work is planned in consultation with traffic police | |
| Work is not being conducted during heavy traffic | |
| Work at a stretch is completed within a day (excavation, pipe laying and backfilling) | |
| Pipe trenches are not kept open unduly | |
| Road is not completely closed; work is conducted on edge; at least one line is kept open | |
| Road is closed; alternative route provided and public informed, information board provided | |
| Pedestrian access to houses is not blocked due to pipe laying | |

| Monitoring Items | Compliance |
|---|------------|
| Spaces left in between trenches for access | |
| Wooden planks/metal sheets provided across trench for pedestrian | |
| No public/unauthorized entry observed in work site | |
| Children safety measures (barricades, security) in place at works in residential areas | |
| Prior public information provided about the work, schedule and disturbances | |
| Caution/warning board provided on site | |
| Guards with red flag provided during work at busy roads | |
| Workers using appropriate PPE (boots, gloves, helmets, ear muffs etc) | |
| Workers conducting or near heavy noise work is provided with ear muffs | |
| Contractor is following standard and safe construction practices | |
| Deep excavation is conducted with land slip/protection measures | |
| First aid facilities are available on site and workers informed | |
| Drinking water provided at the site | |
| Toilet facility provided at the site | |
| Separate toilet facility is provided for women workers | |
| Workers camps are maintained cleanly | |
| Adequate toilet and bath facilities provided | |
| Contractor employed local workers as far as possible | |
| Workers camp set up with the permission of PIU | |
| Adequate housing provided | |
| Sufficient water provided for drinking/washing/bath | |
| No noisy work is conducted in the nights | |
| Local people informed of noisy work | |
| No blasting activity conducted | |
| Pneumatic drills or other equipment creating vibration is not used near old/risky buildings | |

Signature

Sign off

Name
Position

Name
Position

Appendix 7: Quarterly Reporting Format for Madurai Municipal Corporation / PIU

1. Introduction

- Description of sub-project implemented by PIU
- Environmental category of the sub-project
- Details of site personnel and/or consultants responsible for environmental monitoring
- Sub-project status

| No. | Sub-Project Name | Subproject status | List of Works | Progress of Works |
|-----|------------------|---|---------------|-------------------|
| | | Design <input type="checkbox"/> Pre-Construction <input type="checkbox"/> Construction <input type="checkbox"/> Operational Phase <input type="checkbox"/> | | |
| | | | | |

2. Compliance status with National/ State/ Local statutory environmental requirements

| No. | Sub-Project Name | Statutory Environmental Requirements | Status of Compliance | Action Required |
|-----|------------------|--------------------------------------|----------------------|-----------------|
| | | | | |
| | | | | |
| | | | | |

3. Compliance status with environmental loan covenants, if any

| No. (List schedule and paragraph number of Loan Agreement) | Covenant | Status of Compliance | Action Required |
|--|----------|----------------------|-----------------|
| | | | |
| | | | |
| | | | |

4. Compliance status with the environmental management and monitoring plan

- Provide the monitoring results as per the parameters outlined in the EMP. Append supporting documents where applicable, including Environmental Site Inspection Reports.
- There should be reporting on the following items which can be incorporated in the checklist of routine Environmental Site Inspection Report followed with a summary in the semi-annual report send to ADB. Visual assessment and review of relevant site documentation during routine site inspection needs to note and record the following:
 - What are the dust suppression techniques followed for site and if any dust was noted to escape the site boundaries;
 - If muddy water was escaping site boundaries or muddy tracks were seen on adjacent roads;
 - Adequacy of type of erosion and sediment control measures installed on site, condition of erosion and sediment control measures including if these were intact following heavy rain;
 - Are their designated areas for concrete works, and refueling;
 - Are their spill kits on site and if there are site procedure for handling emergencies;
 - Is there any chemical stored on site and what is the storage condition?
 - Is there any dewatering activities if yes, where is the water being discharged;
 - How are the stockpiles being managed;
 - How is solid and liquid waste being handled on site;
 - Review of the complaint management system;
 - Checking if there are any activities being under taken out of working hours and how that is being managed.

Summary Monitoring Table

| Impacts (List from IEE) | Mitigation Measures (List from IEE) | Parameters Monitored (As a minimum those identified in the IEE should be monitored) | Method of Monitoring | Location of Monitoring | Date of Monitoring Conducted | Name of Person Who Conducted the Monitoring |
|-------------------------------|-------------------------------------|---|----------------------|------------------------|------------------------------|---|
| Design Phase | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| Pre-Construction Phase | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| Construction Phase | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| Operational Phase | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Overall Compliance with EMP

| No. | Sub-Project Name | EMP Part of Contract Documents (Y/N) | EMP Being Implemented (Y/N) | Status of Implementation (Excellent/ Satisfactory/ Partially Satisfactory/ Below Satisfactory) | Action Proposed and Additional Measures Required |
|-----|------------------|--------------------------------------|-----------------------------|--|--|
| | | | | | |
| | | | | | |
| | | | | | |

5. Approach and methodology for environmental monitoring of the project

- Brief description on the approach and methodology used for environmental monitoring of each sub-project

6. Monitoring of environmental impacts on project surroundings (ambient air, water quality and noise levels)

- Brief discussion on the basis for monitoring
- Indicate type and location of environmental parameters to be monitored
- Indicate the method of monitoring and equipment to be used
- Provide monitoring results and an analysis of results in relation to baseline data and statutory requirements

As a minimum the results should be presented as per the tables below.

Air Quality Results

| Site No. | Date of Testing | Site Location | Parameters (Government Standards) | | |
|----------|-----------------|---------------|-----------------------------------|--------------------------------------|--------------------------------------|
| | | | PM10 µg/m ³ | SO ₂ µg/m ³ | NO ₂ µg/m ³ |
| | | | | | |
| | | | | | |
| | | | | | |

Water Quality Results

| Site No. | Date of Sampling | Site Location | Parameters (Monitoring Results) | | | | | |
|----------|------------------|---------------|---------------------------------|-----------------------|-------------|-------------|------------|------------|
| | | | pH | Conductivity µS/cm | BOD mg/L | TSS mg/L | TN mg/L | TP mg/L |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

Noise Quality Results

| Site No. | Date of Testing | Site Location | LA _{eq} (dBA) (Government Standard) | |
|----------|-----------------|---------------|--|------------|
| | | | Day Time | Night Time |
| | | | | |
| | | | | |

7. Summary of key issues and remedial actions

- Summary of follow up time-bound actions to be taken within a set timeframe.

8. Appendixes

- Photos
- Summary of consultations conducted, if any
- Copies of environmental clearances and permits
- Sample of environmental site inspection report
- Other

Appendix 8: PUBLIC INFORMATION NOTICE TEMPLATE

**Public Announcement
Madurai Corporation
Providing Dedicated Water Supply Scheme to Madurai City Corporation**

Under this project, works are being conducted by xxxxxxxx Contractor to provide water supply scheme for Madurai Corporation

As part of this, works for laying pipeline network will be taken up in ----- road----/ street/ lane From.....to..... (provide dates).

We request you to kindly co-operate for smooth implementation of the works.

We also request you to drive vehicles / pedestrians to walk carefully

Inconvenience caused is regretted.

PIU - Contact No.

Contractor – Contact no.

Appendix 9: Stakeholder Consultation/ Focussed Group Discussion (FGD) for Dedicated Water Supply Scheme for Madurai Corporation from Mullai Periyar at Lower Camp

Minutes of meeting for “Dedicated Water Supply Scheme for Madurai Corporation from Mullai Periyar at Lower Camp” held at Uthamapalyam Town Panchayat office on 13.03.2018.

Officers Present:

| Sl.No. | Name | Designation |
|---------------|--------------------------|---|
| 1 | Thiru.P.Manivannan | Deputy Commissioner Madurai Corporation |
| 2 | Thiru.A. Mathuram | City Engineer, Madurai Corporation |
| 3 | Thiru J.Balasanmugam | Thasildhar, Uthamapalayam Taluk, Theni District |
| 4 | Thiru. M.Suruli | Head Quarters Thasildhar, Uthamapalayam Taluk, Theni District |
| 5 | Thiru S.Ram Kumar | VAO, Mela Gudalur(South) |
| 6 | Thiru.M.Asokan | Village Assistant Mela Gudalur(South) |
| 7 | Thiru.B.Karutha pandiyan | AEE/VWS, Madurai Corporation |
| 8 | Thiru.P.Mani | JE, Pannaipatti, WTP, Madurai Corporation |

Farmers present:

| Sl.No. | Name | Address/Place |
|---------------|---------------------|----------------------|
| 1 | Thiru P.Gopal | Lower Camp |
| 2 | Thiru.VethaMuthu | Lower Camp |
| 3 | Thiru.R.S.Paramaraj | Gudalur |
| 4 | Thiru.P. Murugesan | Gudalur |
| 5 | Thiru. Veerbabu | Gudalur |
| 6 | Thiru. Asokan | Lower Camp |

The meeting started with a welcome by Thiru.P. Manivannan, Deputy Commissioner of Madurai Corporation. The City Engineer, Madurai Corporation has explained the importance

of the “Dedicated Water Supply Scheme for Madurai Corporation from Mullai Periyar at Lower Camp” and explain the Madurai City Population growth, facilities available, existing drinking water details etc, and the Project Area. At the outset of presentation the following points have been discussed.

- The project head works located in the private land near Lower Camp in Mullai Periyar River and land acquisition has to be made. The City Engineer has requested the land owner to give land for construction of intake well and other components of the project with good opinion.
- The City Engineer further explained the pipeline alignment of the project, the land owner, Thiru Veerbabu has requested the pipeline alignment to be fixed without affecting agricultural land of the farmers
- All the farmers presented in the meeting and have requested that less numbers of farmers were attended in the meeting, hence the meeting may be shifted to Gudalur on 17.03.18. for explaining the project details and getting good opinion from farmers.
- Resolved that the “Dedicated Water Supply Scheme for Madurai Corporation from Mullai Periyar at Lower Camp” with farmers meeting may be shifted to Gudalur on 17.03.18. for further discussion.

At the end of discussion Thiru.A.Mathuram, City Engineer, Madurai Corporation thanked everyone for attending the meeting and putting forward their suggestions for the implementation of the project.

City Engineer

Madurai Corporation

Minutes of meeting for “Dedicated Water Supply Scheme for Madurai Corporation from Mullai Periyar at Lower Camp” held at Gudalur Municipality office Conference on 17.03.2018.

Officers Present:

| Sl.No. | Name | Designation |
|---------------|--------------------------|---|
| 1 | Thiru.P.Manivannan | Deputy Commissioner Madurai Corporation |
| 2 | Thiru.A. Mathuram | City Engineer, Madurai Corporation |
| 3 | Thiru J.Balasanmugam | Thasildhar, Uthamapalayam Taluk, Theni District |
| 4 | Thiru. M.Suruli | Head Quarters Thasildhar, Uthamapalayam Taluk, Theni District |
| 5 | Thiru S.Ram Kumar | VAO, Mela Gudalur(South) |
| 6 | Thiru.M.Asokan | Village Assistant Mela Gudalur(South) |
| 7 | Thiru.B.Karutha pandiyan | AEE/VWS, Madurai Corporation |
| 8 | Thiru.P.Mani | JE, Pannaipatti, WTP, Madurai Corporation |

Farmers / Public Present:

| S.I.No: | Name | Designation |
|----------------|------------------|---|
| 1. | C. Dravidamani | Advisor ,Makkal Mantram |
| 2. | V.Krishnamurthy | Assistant president, Makkal Mantram |
| 3. | P.A. Mahindra | Makkal Mantram |
| 4. | P.K.R. | N.S.K.& Farm Manager |
| 5. | K.P.M. Matharsha | President, Makkal Mantram |
| 6. | K.S. Veerbabu | All Farmers Association |
| 7. | K. Shajahan | Secretary, Association for City welfare Service |
| 8. | K. Prakhas | Farmer |
| 9. | S. Prabhakaran | Reporter, Dinamani |
| 10. | S.S.Murugan | Reporter, Dinathanthi , Malaimazhar |

| S.I.No: | Name | Designation |
|----------------|--------------------|---|
| 11. | P.Pandikumar | Reporter, Danthi TV |
| 12. | N.Senthil kumar | Natural Farmers Association, Theni District |
| 13. | M.Natarajan | Gudalur |
| 14. | C. Silambarasan | General Secretary for Youth, Theni District |
| 15. | D.Raju | Farmers Association |
| 16. | N.Jeyapal | Farmer – Treasurer |
| 17. | V. Kodiarasan | Farmer |
| 18. | N. Mohamed Ibrahim | Gudalur |
| 19. | K. Sangappan | Gudalur |
| 20. | R. Karnan | Gudalur |
| 21. | M.Senkuttuvan | Gudalur |
| 22. | S. RamKumar | VAO, Mela Gudalur(South) |
| 23. | Tmt.C.Saroja | Lower Camp |

The meeting started with a welcome by Thiru.P. Manivannan, Deputy Commissioner of Madurai Corporation. The City Engineer, Madurai Corporation has explained the importance of the Dedicated Water Supply Scheme for Madurai Corporation from Mullai Periyar at Lower Camp” and explain the Madurai City Population growth, facilities available, existing drinking water details etc, and the Project Area. At the outset of presentation, the following points have been discussed.

1. The Following Members have stated in the Meeting about water shortage in the Theni District due to Implementation of “Dedicated Water Supply Scheme for Madurai Corporation. They have raised the same queries about water drawal from the Periyar Dam and whether it will affect the irrigation facilities of the farmer in the Theni District.

1. Senguttuvan, Deputy Secretariat, All former association Theni District
2. Rajiv, District President, All farmer association Theni District
3. Senthilkumar, Deputy President, All farmer association Theni District
4. V.Krishnamoorthy, Public Association Gudalur
5. P.A Gajendran, Public Association Gudalur
6. K.P Matharsha, President Public Association Gudalur
7. Dhiravidamani, Public Association Gudalur
8. Subramanian, Public Association Gudalur

9. Veerbabu, All farmer association Gudalur
10. Shajahan, All farmer association Gudalur
11. Pudhurasu, Tamilnadu Consumer Organiser

The City Engineer Madurai Corporation has replied that in the Periyar Dam 200 Cusecs has been allotted for drinking water to the Madurai Corporation in the allotted quantity only 50 Cusecs will be drawn for above scheme. Remaining 150 Cusecs will be in the river flow and while implementation of Mullai Periyar Scheme will not affect the irrigation and drinking water facilities.

2. In the Meeting Tmt.Saroja, The landowner of Proposed Head Works has agree to give her land for construction of intake wells and other components.

At the end of discussion Thiru.A.Mathuram, City Engineer, Madurai Corporation thanked everyone for attending the meeting and putting forward their suggestions for the implementation of the project.

City Engineer

Madurai Corporation

Public Hearing Attendees

Madurai Corporation

Meeting: AMRUT - Mullaipeiyar Meeting.

Date: 08.03.18, Time: 05:00 P.M

Venue: Conference Hall

| Sl No. | Name | Designation | Signature |
|--------|--------------------|--|-------------|
| 1 | J. SELVAM | Joint Sec T.N. Chamber ^{Madurai} | 9421-51818 |
| 2 | H. JAFFER SADIQ | Asst. Governor / Re Rotary Club | 98947 80009 |
| 3 | T. Saravanan | Exec LIA | 94428-17178 |
| 4 | T.K. Sivakumar | President, Rotary Club of MADURAI | 934402130 |
| 5 | S. Chandran | Convener, Environment Panel, C.I. Madurai | 9444108500 |
| 6 | S. Selvan | WR Zone IV | 97858 10186 |
| 7 | O. Arasu | ER Z1 | 94437 39519 |
| 8 | S. N. Rajendran | ER Z2 | 9442639545 |
| 9 | S. Chinnabhaiyan | ER Zone 3 | |
| 10 | S. Rajanathan | CELPJ | |
| 11 | S. RETHINAVELU | Sr. President T.N. Chamber | 98430 53153 |
| 12 | M. Venkatasalapati | MADURAI ALUMNI | 9994596640 |
| 13 | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Meeting: Dedicated water supply, for Madurai Corporation.

Date: 13.03.2016 Time:

Venue: Mullai Periyar meeting

| Sl. No. | Name | Designation | Signature |
|---------|--|---------------------------|-------------------------|
| 1 | [Handwritten Name] | [Handwritten Designation] | [Handwritten Signature] |
| 2 | [Handwritten Name] | [Handwritten Designation] | [Handwritten Signature] |
| 3 | P. [Handwritten Name] | [Handwritten Designation] | [Handwritten Signature] |
| 4 | [Handwritten Name] | [Handwritten Designation] | [Handwritten Signature] |
| 5 | M. [Handwritten Name] | [Handwritten Designation] | [Handwritten Signature] |
| 6 | [Handwritten Name] | [Handwritten Designation] | [Handwritten Signature] |
| 7 | R.S. [Handwritten Name] ([Handwritten Title]) | [Handwritten Designation] | [Handwritten Signature] |
| 8 | [Handwritten Name] | [Handwritten Designation] | [Handwritten Signature] |
| 9 | [Handwritten Name] | [Handwritten Designation] | [Handwritten Signature] |
| 10 | [Handwritten Name] | [Handwritten Designation] | [Handwritten Signature] |
| 11 | B. [Handwritten Name] | AER/VWS | [Handwritten Signature] |
| | | | |
| | | | |

Madurai Corporation

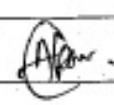
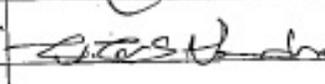
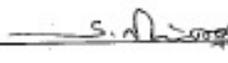
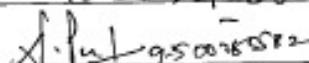
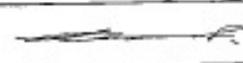
(5)

Meeting:

Date: 16/3/18, Time:

Venue: அலுவலர் அலுவலகம்

மாநகர குடியரசு உட்கட்சிணக்குழு
 உட்கட்சிணக்குழு குடியரசின் கீழ்

| Sl. No. | Name | Designation | Signature |
|---------|--------------------------|--|---|
| 1 | தி. அருண்மொழி | கணினி லட்சுமி நாராயணன் தலைவர் |  |
| 2 | சு. ச. சிவசுப்பிரமணியன் | கணினி துறை உதவி இயக்குநர் WD 31 & 32 |  |
| 3 | பி. சி. சிவசுப்பிரமணியன் | கணினி துறை உதவி இயக்குநர் WD 31 & 32 |  |
| 4 | சி. சி. சிவசுப்பிரமணியன் | கணினி துறை உதவி இயக்குநர் |  |
| 5 | R. சிவசுப்பிரமணியன் | கணினி துறை உதவி இயக்குநர் |  9862010090 |
| 6 | சி. சி. சிவசுப்பிரமணியன் | கணினி துறை உதவி இயக்குநர் | 9364576426 S. சிவசுப்பிரமணியன் |
| 7 | தி. சி. சிவசுப்பிரமணியன் | கணினி துறை உதவி இயக்குநர் | தி. சி. சிவசுப்பிரமணியன் 1613 986554138 |
| 8 | D. Perumal | கணினி துறை உதவி இயக்குநர் |  95008582 |
| 9 | சி. சி. சிவசுப்பிரமணியன் | கணினி துறை உதவி இயக்குநர் | சி. சி. சிவசுப்பிரமணியன் 9245483086 |
| 10 | N. சிவசுப்பிரமணியன் | கணினி துறை உதவி இயக்குநர் | N. சிவசுப்பிரமணியன் |
| 11 | S. சிவசுப்பிரமணியன் | கணினி துறை உதவி இயக்குநர் |  |

Madurai Corporation

(6)

Meeting:

Date... 16.12.18... Time.....

Venue: collector office

| Sl. No. | Name | Designation | Signature |
|---------|--------------------------|---|-----------|
| 13. | R. VISWANATH | EE/PMC Division (I/c) Melur | |
| 14 | G. Jeyaraj | Asst (S.L) | |
| 15 | P. Nagaday | HM (C&E) | |
| 16 | Baskaran | CSE (S&A) Sec | |
| 17 | T. Prasad | P.N.H.B. 1, 2, Sector D. M. M. Sec | |
| 18 | T. N. HARI KESAVAN | T.N.H.B. 1, 2, 3 Sec Analyst Madurai | |
| 19 | C. GNAYAGAN S. Pravin | P.N.H.B. Ch. Analyst Madurai-12 | |
| 20 | A. ALWAR | Viswanathaperaru | |
| 21 | A SHEIKS HUSSAIN | Extra Resident's Welfare & Associate | |
| 22 | P. SADAYAPPA | Mangalavinayaga Nagan & Adangala Madurai-17 | |
| 23 | | | |
| 24 | R. K. S. S. S. S. | Asst. Secy | |
| 25 | Dr. S. S. S. | Asst. Secy | |
| 26 | P. Chandra Sekaran | Public Town Secretary P & Town Secy | |

| | | | |
|----|------------------|----------|-----------------------------|
| 31 | A. Pradipniranda | Advocate | A. Pradipniranda |
| 32 | R. Pradipniranda | Advocate | A. Pradipniranda 9865441996 |
| 33 | N. Pradipniranda | Advocate | N. Pradipniranda 9500206431 |
| 34 | V. Pradipniranda | Advocate | V. Pradipniranda 9442126778 |
| 35 | R. Pradipniranda | Advocate | R. Pradipniranda 8903503962 |
| 36 | B. Pradipniranda | Advocate | B. Pradipniranda |
| 37 | V. R. G. Mohan | Advocate | V. R. G. Mohan 9944210711 |
| 38 | M. Srinivasan | Advocate | M. Srinivasan |
| 39 | G. Rajendran | Advocate | G. Rajendran 9443471865 |
| 40 | N. Pradipniranda | Advocate | N. Pradipniranda |

Madurai Corporation

9

Meeting :

Date... 16/11/18... Time.....

Venue: Collector's Office

| Sl. No. | Name | Designation | Signature |
|---------|-------------------|-------------|-------------------|
| 54 | M. Stephen Antony | தினியல் | 950954012 |
| 55 | Y. S. S. S. S. S. | தினியல் | 950954012 |
| 56 | K. S. S. S. S. S. | தினியல் | 950954012 |
| 57 | I. S. S. S. S. | தினியல் | 9894345738 |
| 58 | M. S. S. S. S. | தினியல் | 9946392619 |
| 59 | S. S. S. S. S. | தினியல் | 9600949809 |
| 60 | S. S. S. S. S. | தினியல் | 9629659818 |
| 61 | M. S. S. S. S. | தினியல் | 978788220 |
| 62 | M. S. S. S. S. | தினியல் | 6381632540 |
| 63 | M. S. S. S. S. | தினியல் | 6791701870 |
| 64 | L. S. S. S. S. | தினியல் | 9952485440 |
| 65 | M. S. S. S. S. | தினியல் | 9682389988 |
| 66 | R. S. S. S. S. | தினியல் | 9682389988 |
| 67 | K. R. K. K. K. | தினியல் | K. R. K. K. K. |
| 68 | P. S. S. S. S. | தினியல் | P. S. S. S. S. |
| 69 | M. K. S. S. S. S. | தினியல் | M. K. S. S. S. S. |

Madurai Corporation

(10)

Meeting:

Date.....16/3/18....., Time.....

Venue: Collector Office

| Sl No. | Name | Designation | Signature |
|--------|-------------------|------------------------------------|------------------------|
| 70 | R. Jeya | ASSISTANT ENGINEER | R. Jeya 16/03/18 |
| 71 | R. ROJASEANI | A.B. | [Signature] 16/3/18 |
| 72 | M. Poomani | AE | [Signature] 16/3/18 |
| 73 | S. Hanjula Devi | AE | [Signature] 16/3/18 |
| 74 | R. Kann | Assistant Engineer Madurai Corp | [Signature] 16/3/18 |
| 75 | P. V. Krishna | Asst. Engr, Madu. Corp | [Signature] 16/3/18 |
| 76 | K. MALLERIMATHAN | Asst. Engineer Madu. Corp. | [Signature] 16/3/18 |
| 77 | J. Suresh Kumar | AE Madu. Corp | [Signature] 16/3/18 |
| 78 | M. S. S. S. S. S. | MS | [Signature] |
| 79 | [Signature] | MS | [Signature] |
| 80 | K. S. Kanthappa | AE | [Signature] |
| 81 | M. Braganza | A.E | [Signature] 16/3/18 |
| 82 | V. ARUMUKAM | AE | [Signature] 16/3/18 |
| 83 | M. MUNERANMAD | A.E, ward (94 to 99) | [Signature] 16/3/18 |
| 84 | S. Kulambaiyal | AE | [Signature] |
| 85 | K. Sankari | JE, ward 30, 33, 35 | [Signature] 16/3/18 |
| 86 | R. Sankar/Kumar | AE/Cooperation | [Signature] 16/3/18 |

Madurai Corporation

11

Meeting:

சென்னை மாநகராட்சி நிர்வாகக் குழு

Date: 17/3/18, Time: 12:00 P.M.

சென்னை மாநகராட்சி

Venue: மாநகராட்சி

| Sl. No. | Name | Designation | Signature |
|---------|---------------------|---------------------|-------------|
| 1 | C. Davidmani | கல்வி கமிஷனர் | [Signature] |
| 2 | V. சிவசுப்பிரமணியன் | கல்வி கமிஷனர் | V. S. |
| 3 | M. சந்திரசேகரன் | கல்வி கமிஷனர் | [Signature] |
| 4 | P.K. Pambath | நகர நிர்வாக அலுவலர் | [Signature] |
| 5 | K. சந்திரசேகரன் | கல்வி கமிஷனர் | [Signature] |
| 6 | K.S. சந்திரசேகரன் | கல்வி கமிஷனர் | [Signature] |
| 7 | K. சந்திரசேகரன் | கல்வி கமிஷனர் | [Signature] |
| 8 | B. சந்திரசேகரன் | கல்வி கமிஷனர் | [Signature] |
| 9 | S.S. சந்திரசேகரன் | கல்வி கமிஷனர் | [Signature] |
| 10 | S.S. சந்திரசேகரன் | கல்வி கமிஷனர் | [Signature] |
| 11 | P. சந்திரசேகரன் | கல்வி கமிஷனர் | [Signature] |
| 12 | N. சந்திரசேகரன் | கல்வி கமிஷனர் | [Signature] |
| 13 | M. சந்திரசேகரன் | கல்வி கமிஷனர் | [Signature] |
| 14 | C. சந்திரசேகரன் | கல்வி கமிஷனர் | [Signature] |
| 15 | Rajiv | கல்வி கமிஷனர் | [Signature] |
| 16 | N. சந்திரசேகரன் | கல்வி கமிஷனர் | 8754810130 |
| 17 | S. சந்திரசேகரன் | கல்வி கமிஷனர் | 9787519515 |

Photographs of Meeting with landowner held at Gudalur for the dedicated water supply scheme for MaduraiCorporation from Mullai Periyar



Photographs of Public Consultation Meeting held at Uthamapalayam for the dedicated water supply scheme for Madurai corporation from mullai periyar



9
20/7/18



Handwritten signature and date 21/9/2018

018532 ABSTRACT

Water Resources Department – Combined Water Supply Schemes- Drawal of water by Tamil Nadu Water Supply and Drainage Board to Theni, The Nilgiris, Dindigul, Madurai and Coimbatore Districts from Government Sources- Schemes Recommended by the Technical Sub-Committee involving drawal of water of 1 MGD and above – Approved by the Water Utilisation Committee – Permission Granted- Orders- issued.

G.O (40) No.8

Public Works (WZ) Department

Dated : 23.7.2018

சென்னை, ஆகத்து 7

தமிழக அரசின் ஆணை 2018

Handwritten initials HG and PWC

Read:-

- 1. G.O. (Ms) No. 700, Public Works Department, dated 18.10.1995.
- 2. G.O.(Ms) No.242, Public Works Department, dated 28.11.2006.

Read also:-

- 3. From the Engineer-in-Chief, Water Resources Department Chennai Letter No. S7(1)/ 72508/OT-W/1996, dated 18.12.2017.

ORDER:-

In his letter third read above the Engineer-in-Chief, Water Resources Department, Chennai has forwarded the proposal of water supply schemes, involving drawal of water of 1 MGD (Million Gallon per Day) and above from Government sources which were already approved in the 6th Technical Sub-Committee meeting and recommended to place before the Water Utilization Committee, for consideration and clearance.

2. Based on this, The Water Utilization Committee meeting held on 20.12.2017 under the Chairmanship of the Principal Secretary to Government, Public Works Department approved the proposals submitted by the Tamil Nadu Water Supply and Drainage Board and Madurai Corporation which were recommended by the Technical Sub-committee in its 40th meeting.

3. After careful examination, the Government have decided to accept the recommendations of the Water Utilization Committee and permit the Tamil Nadu Water Supply and Drainage Board in Theni, The Nilgiris, Dindigul and Coimbatore Districts and Madurai Corporation to draw water from the respective sources, as detailed below subject to the usual terms and conditions which are appended to this order.

- (i) for drawal of 2.08 mgd of surface water from the pickup weir on the downstream side of Vaigai Dam in Theni District for providing CWSS to Vadugapatty Town Panchayat and 57 other Rural Habitations in Peiryakulam Union and Horticulture College in Theni District Battagundu Town, Panchayat in Dindigul District.
- (ii) for drawal of 12.74 mld of surface water from Emerald Reservoir in The Nilgiris District for providing Combined Water Supply Scheme (CWSS) to Coonoor Municipality, Wellington Military Station and Pasteur Institute of India, Coonoor.
- (iii) for drawal of 1.42 mgd (6.46 mld) of surface water from Keel Gundar River through a leading channel on the upstream side of proposed check dam in Keel Gundar River for providing Water Supply Improvement Scheme (WSIS) to Kodaikanal Municipality, in Dindigul District.
- (iv) for drawal of 125mld (27.50mgd/51.09cusecs), for dedicated Water Supply Scheme for Madurai Corporation from Mullai Periyar River at Lower Camp being the intermediate stage requirement as of the year 2034, subject to the conditions that the Madurai Corporation to design the Scheme for drawal of Water from Mullai Periyar River in holistic manner such that waste water generated in Madurai Corporation has to be collected, treated and reused to avoid reduction in water supply to irrigation and subject to the usual terms and conditions stipulated by Chief Engineer, Water Resources Department, Madurai region.
- (v) for a quantum of 178.30 mld from Bhavani barrage - I at Samayapuram being the intermediate stage requirement as of the year 2035 for Water Supply Improvement Scheme to Expanded Coimbatore Corporation including newly merged areas with River Bhavani as source.
- (vi) wherever intermediate water requirement is approved by Water Utilisation Committee, Tamil Nadu Water Supply and Drainage Board or other organizations may approach Water Utilisation Committee afresh at the appropriate time regarding review and approval for their ultimate water requirement.

4. The Engineer-in-Chief, Water Resources Department, and Chief Engineer (General), Chennai and respective Regional Chief Engineers are also directed to permit the Tamil Nadu Water Supply and Drainage Board in Theni, The Nilgiris, Dindigul and Coimbatore Districts and the Madurai Corporation to draw the specified quantity of water from the specified places subject to the terms and conditions stipulated in the annexure to this order. Water charges shall be levied in accordance with the orders in force.

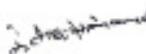
(By order of the Governor)

S.K. Prabakar
Principal Secretary to Government

To
The Additional Chief Secretary and
Commissioner of Land Administration, Chepauk, Chennai-5.

The Engineer-in-Chief, Water Resources Department, and
 Chief Engineer (General), Public Works Department, Chennai-5.
 The Chief Engineer, Water Resources Department,
 Coimbatore Region, Coimbatore.
 The Chief Engineer, Water Resources Department,
 Madurai Region, Madurai.
 The Managing Director,
 Tamil Nadu Water Supply and Drainage Board, Chennai - 5.
 The District Collectors,
 Theni District, The Nilgiris District, Dindigul District,
 Madurai District and Coimbatore Districts
 The Commissioner, Corporation of Madurai, Madurai
 The Additional Chief Secretary to Government,
 Industries Department, Secretariat, Chennai - 9.
 The Principal Secretary to Government,
 Municipal Administration & Water Supply Department,
 Secretariat, Chennai - 9.
 The Agriculture production, Commissioner and Principal Secretary to Government,
 Agriculture Department, Secretariat, Chennai - 9.
 The Chief Engineer, State Ground & Surface Water Resources Data Centre,
 Water Resources Department, Chennai - 113.
 The Chief Engineer, Plan Formulation, Chennai-5
 The Chief Engineer, Design Research and Construction Support,
 Water Resources Department, Chennai - 5.
 The Commissioner of Agriculture, Chennai - 5.
 The Engineering Director, Tamil Nadu Water Supply and Drainage Board, Chennai - 5.
 The Chief Engineer, Operations and Maintenance, Chapsak, Chennai-5.
 The Chief Engineer and Director, Institute of Water Studies,
 Water Resources Department, Taramani, Chennai - 113.
Copy to:
 The Hon'ble Chief Minister's Office, Chennai - 8.
 The Resident Audit Officer,
 Office of the Principal Accountant General
 (General and Social Sector Audit),
 Tamil Nadu Secretariat, Chennai-9.
 The Principal Accountant General (Audit-I), Chennai - 18.
 Stock File / Spare Copy

// Forwarded by order//


 Section Officer

Annuxure of G.O. (4D) No.6, Public Works (W2) Department, Dated 23.7.2018

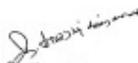
**Conditions for drawal of water from Government sources by the TWAD Board/
Madurai Corporation**

1. The Technical and Economical – viability of the scheme will be left to the Tamil Nadu Water Supply and Drainage Board (TWAD)/ Madurai Corporation.
2. The present drawal should not affect the existing water supply to the nearby villages etc.,
3. The construction of collection wells cum pump house should not obstruct the free flow of water in the river and the location should be decided in consultation with the Chief Engineer, Water Resources Department of the concerned Region.
4. The proposed tapping point for the present proposal should be 500 metre away from the abstractions area in the River near the existing collection wells, if any available for the water supply schemes.
5. No damages should be caused to the riverbanks during the process of laying pipelines across the river. If any damages are caused, it should be rectified by the TWAD Board/ Madurai Corporation at their cost.
6. Free flow of water in the river should be ensured.
7. Laying of pipe lines should be done at least 1.5 m below the deepest bed level of the river.
8. Necessary protective works for the riverbanks on either side should be made where the pipelines cross the river.
9. The construction works in the river should be executed only in the presence of the field officers of Water Resources Department, PWD.
10. The TWAD Board, Municipality, Panchayats, etc./ Madurai Corporation should not come up with any request for special release of water for recharging the bed of the river during non-flow season.
11. The TWAD Board, Municipality, Panchayat etc., / Madurai Corporation have to pay necessary royalty charges (fixed by the Government from time to time) for the industrial and commercial demands.
12. Measuring devices (water meter) must be provided by the TWAD Board/ Madurai Corporation to calculate the quantity of water drawn out of the above source.

- Approaches for checking the water meter must be provided by the TWAD Board/ Madurai Corporation.
13. The proposed drawal quantity of water should not be exceeded in future without the approval of the Water Utilisation Committee and the Government.
 14. An agreement is to be executed by the TWAD Board/ Madurai Corporation with Water Resources Department, Public Works Department for drawal of water.
 15. Concurrence of the District Collector should be obtained before commencement of the scheme.
 16. Resolution of the local body should be obtained before commencement of the scheme.
 17. Necessary treatment plants should be established with adequate infrastructure for collection of sewage and sullage and treated effluent of accepted standards should be allowed to be discharged anywhere within the sub basin for ground water recharging with separate recharging structures.

S.K. Prabakar
Principal Secretary to Government

// True copy//


Section Officer

Appendix 11

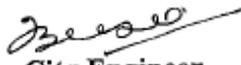
PRESENT ACTIVITY STATUS

Madurai Corporation

Dedicated Water Supply Scheme from Mullai Periyar at Lower Camp – Status as on 21.07.2018

| Sl. No. | Name of the Department | Subject/Permission Needed | Present Status |
|---------|---|---|--|
| 1. | The Regional Officer National Highways, Besant Road, Chennai – 600 025. | NH 85 – 8.00 Km from Aranmanai Pudur Junction to Kanavilaku Junction | The Regional Officer has recommended for laying pipe in NH 85 for 8.00 Km. Copy of the letter is enclosed. |
| 2. | The Regional Officer National Highways Authority of India, Vilangudi, Madurai | 1) NHAI 183 (45E & 220) – 52.00 Km from Lower Camp – Theni Section 2) NHAI 7 – Four way Crossing at Samayanallur | 1) Theni Section - The Regional Officer has recommended for laying pipe in NHAI 183 for 52.00 Km. Copy of the letter is enclosed. 2) Four way Crossing – Permission obtained. |
| 3. | The Divisional Railway Manager Southern Railway Division, Madurai. | 1) Madurai - Bodinayakanur Line L.C.No. 68 (Km 72/6-7) 2) Madurai – Dindigul Karrupatti L.C. No. 341 (Km 470/25-27) 3) Madurai – Dindigul Nedunkulam L.C. No. 349 (Km 476/5-6) | Acceptance letter given by the Divisional Railway Manager. |
| 4. | The Divisional Engineer State Highways Department, Theni. | 1) SH – 8.00 Km from Veerpandi to Aranmanai Pudur NH Junction. 2) SH 101 – 8.00 Km from Kanavilaku to Vaigai Dam Roundana. | The Divisional Engineer has accepted the proposal. Necessary NOC will be released on remittance of the Road Cut Restoration charge to Divisional Engineer. |

| Sl. No. | Name of the Department | Subject/Permission Needed | Present Status |
|---------|--|---|--|
| 5. | The Superintending Engineer State Highways, Madurai Circle, Alagar Kovil Road, Madurai - 625 001. | 1) SH 73 - 5.60 Km from Mattaparai to Karuppatti 2) SH - 3.00 Km from Nedukulam to Melakkal New Bridge 3) SH - 6.00 Km from Melakkal New Bridge to Samayanallur NHAI Road Junction 4) SH100 - 10.00Km Samayanallur NHAI Road Junction to Theekathir Office | The Divisional Engineer has accepted the proposal. Necessary NOC will be released on remittance of the Road Cut Restoration charge to Divisional Engineer. |
| 6. | The Executive Engineer Public Works Department - WRO Periyar - Vaigai Division, Madurai. | 1) 2.00 Km from Vaigai Dam SH Road Roundana to Downstream of Pick Weir 2) 21.00 Km from Pannaipatti WTP to SH Road-73 at Karatupatti | The proposal has been accepted. Awaiting for NOC from CE, WRO, Madurai. |


City Engineer
Madurai Corporation

Appendix 12: Status Note on Safety Aspects Related to Associated Facility

Tamil Nadu Urban Flagship Improvement Project (TNUFIP) - Madurai Water Supply Improvement Scheme Proposed in Tranche 2

Status Note on Safety Aspects Related to Associated Facility – The Mullai Periyar Dam

A. SUB-PROJECT PROFILE

- Sub-project involves augmentation of water supply to Madurai Corporation.
- Releases from Mullaperiyar Dam abstracted at Lower Camp is the source of raw water for this sub-project.
- Sub-project scope involves abstraction of 125 MLD raw water with check dam and river intake arrangement, pumping based raw water transmission, WTP of 125 MLD clear water capacity and gravity based clear water transmission to 56 OHTs in Madurai City including SCADA arrangement.
- Distribution system improvement (per ULB as indicated in revised DPR) is under review at GoTN level for funding through parallel financing arrangement (not under scope of ADB TNUFIP).

B. MULLAI PERIYAR DAM DISPUTE

- Mullaperiyar Dam is in the state of Kerala, but is owned and operated by the state of Tamil Nadu on a long term lease agreement between the states.
- The dam was constructed during 1887-1895. Its Full Reservoir Level (FRL) is 152 ft and it provides water through a tunnel to Vaigai basin in Tamil Nadu for irrigation benefits in 68,558 hectares area².
- In 1979, Government of Kerala citing safety concerns of the dam due to observed leakages through the structure, requested Government of India to depute a team from Central Water Commission, the apex water resources organization of India, to inspect the dam. Upon inspection and subsequent joint meeting held, it was felt that some strengthening works are required and in the meantime, it was recommended to maintain water level in the reservoir at 136.00 ft. After undertaking emergency and medium-term strengthening measures, in subsequent meeting held in 1980, it was opined that water level in the reservoir can be restored up to 145 ft. (44.2 m)³.
- However, restoration of FRL to pre-1979 period and safety concerns of the dam has been part of an inter-state dispute between the State Governments of Kerala and Tamil Nadu.
- Honorable Supreme Court (SC) of India through Order in W.P.(C) No. 386/2001 dated 27.2.2006 and subsequently through Order dated May 07, 2014 “ORIGINAL SUIT NO. 3 of 2006” permitted Govt. of Tamil Nadu to raise the water level from 136.00 ft. to 142.00 ft and ultimately to 152.00 ft after completion of further strengthening measures on the Mullaperiyar Dam⁴. Though after the 2006 order of the SC, the state legislature

²Ministry of Water Resources, River Development & Ganga Rejuvenation, Government of India – Note on “Mullaperiyar Dam Issue” URL ref.:

³ Para.4, Page 2 of 158 and Para.5, Page 3 of 158, Honorable Supreme Court of India Order dated May 07, 2014.

⁴<http://mowr.gov.in/acts-tribunals/other-inter-state-water-disputes/mulla-periyar-dam-issue>
3 Para.199, Page 144 of 158, Point No.(iii), S.C. Order dated May 07, 2014.

of Kerala had passed the Irrigation and Water Management (Amendment) Act that fixed the maximum water level of Mullai Periyar Dam to 136 feet, but this act was declared unconstitutional by the SC Order of May 07, 2014. Kerala has also made an offer to build a new dam and subsequently decommission the existing dam, but Supreme Court maintained that this could be done only on mutual agreement and cannot be thrust upon Tamil Nadu.

C. SUPREME COURT ASSESSMENT OF THE SAFETY ASPECTS OF MULLAI PERIYAR DAM

Constitution Bench of Honorable Supreme Court of India, on 18.02.2010, directed the Central Government of India to constitute an Empowered Committee (EC) under the chairmanship of Dr. A. S. Anand, Former Chief Justice of India and comprising of two members nominated by the States of Kerala and Tamil Nadu and two renowned technical experts⁴.

- The EC got investigations, tests and technical studies carried out through three apex organizations, besides other specialized organizations of the Government of India and, especially, expert agencies with a view to appreciate the diverse stand of the two States⁵.
- EC submitted the Report comprising eight chapters. Chapter VI comprises analysis and appraisal of ITS Report (Investigations, Tests and Studies) in the areas of A) Hydrological Safety; B) Structural Safety; and C) Seismic Safety⁶. Details of tests performed are also included in reference paragraph.
- EC has summarized its conclusions on the three aspects namely;

(i) **A) Hydrologic Safety** – “The Mullaiperiyar Dam is found hydrologically safe” with reference to Probable Maximum Flood (PMF) and FRL⁷.

(ii) **B) Structural Safety** - Both the main and Baby Dam (gravity and earth), are structurally safe. FRL can be restored to the pre-1979 position. Maintenance and repair measures to be carried out in a time-bound manner are also specified⁸.

(iii) **C) Seismic Safety** - MPD is found to be seismically safe for FRL 152 ft (46.33 m)/ MWL 155 ft (47.24 m) for the identified seismic design parameters with acceleration time histories under 2-D FEM Analysis⁹.

- Govt. of Kerala subsequently challenged the EC Report and its conclusions¹⁰. The Court did not find any merit in the objections of Govt. of Kerala challenging the findings and conclusions of the EC Report and concluded that “...there is no change in circumstances at all much less any drastic change in circumstances or emergent situation justifying the reopening of safety aspect of Mullaperiyar dam which has been determined by this Court in the earlier judgment.”¹¹.

4 Para.184, Page 132 of 158, S.C. Order dated May 07, 2014.

5 Para.184, Page 132 of 158, S.C. Order dated May 07, 2014.

6 Para.188, Page 134 of 158 to Page 137 to 158 (incl.), S.C. Order dated May 07, 2014.

7 “A) Hydrologic Safety” #23, Para.195, Page 140 of 158, S.C. Order dated May 07, 2014

8 “B) Structural Safety” #24, Para.195, Page 140 of 158, S.C. Order dated May 07, 2014 - Maintenance and Repair measures viz. i) treatment of upstream surface, ii) reaming of drainage holes, iii) instrumentation, iv) periodical monitoring, analysis and leading away the seepage from toe of the dam towardsdownstream, v) geodetic re-affirmation, etc., vi) the dam body should be

grouted with a properly designed grout mix of fine cement / suitable chemical / epoxy / polymer according to expert advice so that its safety continues to remain present.

9 "C) Seismic Safety" #25, Para.195, Pages 140 and 141 of 158, S.C. Order dated May 07, 2014

10 Para.195, Pages 141 and 142 of 158, S.C. Order dated May 07, 2014.

11 Para.198, Pages 143 of 158, S.C. Order dated May 07, 2014.

D. DECISION OF SUPREME COURT ON IRRIGATION AND DRINKING WATER REQUIREMENT

- Kerala argued in SC that Tamil Nadu has not suffered any injury due to reduction in storage by maintaining the FRL at 136.00 ft from 1979 and that in fact the area under irrigation has increased post 1979 period.
- But Tamil Nadu maintained that raising water level in the dam to original FRL is necessary to irrigate lands in five drought-prone districts of Theni, Dindigul, Madurai, Sivagangai and Ramanathanpuram. GoTN also stressed that not only 680,000 farmers and agricultural labourers but also 8 Million people of the above five districts shall continue to suffer due to inadequate timely supply of water for irrigation and drinking purposes if the dam level is maintained at 136 ft.

- EC considered the above aspects and observed that;

(i) Increase in irrigation in Vaigai Basin was mainly due to i) Construction of Vaigai Dam (1954) and related canal distribution system (1974), ii) World Bank funded Modernization of Periyar Vaigai Irrigation Project – Phase I & II (1980s).

(ii) There is still large drought-prone area in Vaigai Basin and adjoining area, which needs protective irrigation. Also domestic / municipal / industrial needs of the area are significant. These present requirements remain unmet, if FRL is not restored even partially.¹²

(iii) Further, the EC has also observed that “the inadequate timely water supply of water for irrigation and drinking purposes to the population of the above mentioned 5 districts may affect their lives as well as livelihood. The increase of irrigation and more drawal of water post 1979 still appears to be deficient for the population of more than 8 million people in these districts”.¹³

E. APPOINTMENT OF SUPERVISORY COMMITTEE

- Honorable Supreme Court of India, through the Order dated May 07, 2014, has directed formation of a three (3) member Supervisory Committee. Para 222 of above SC Order states that “However, to allay the apprehensions of Kerala - though none exists - about the safety of the Mullai periyar dam on restoration of the FRL to 142 ft., a 3-Member Supervisory Committee is constituted”.

- The Committee shall have one representative from Central Water Commission and one representative each from the two States, Tamil Nadu and Kerala. The representative of Central Water Commission shall be the Chairman of the Committee.

- The powers and functions of the Supervisory Committee shall be as follows:

(i) The Committee shall supervise the restoration of FRL in the Mullai periyar dam to the elevation of 142 ft.

¹² Para.218, Pages 153 and 154 of 158, S.C. Order dated May 07, 2014.

¹³ Para.219, Page 154 of 158, S.C. Order dated May 07, 2014.

(ii) The Committee shall inspect the dam periodically, more particularly, immediately before the monsoon and during the monsoon and keep close watch on its safety and recommend measures which are necessary. Such measures shall be carried out by Tamil Nadu.

(iii) The Committee shall be free to take appropriate steps and issue necessary directions to the two States - Tamil Nadu and Kerala – or any of them if so required for the safety of the Mullai periyar dam in an emergent situation. Such directions shall be obeyed by all concerned.

(iv) The Committee shall permit Tamil Nadu to carry out further precautionary measures that may become necessary upon its periodic inspection of the dam in accordance with the guidelines of the Central Water Commission and Dam Safety Organization.

- In accordance with directions of the Honorable Supreme Court, the Cabinet has accorded its approval on 18.06.2014 for setting up of the Supervisory Committee on Mullai periyar Dam with the following members¹⁴:

(i) Chairman ex-officio - Chief Engineer, Dam Safety Organisation, Central Water Commission

(ii) Member ex-officio - Principal Secretary, Public Works Department, Govt. of Tamil Nadu.

(iii) Member ex-officio – Additional Chief Secretary, Water Resources Department, Govt. of Kerala

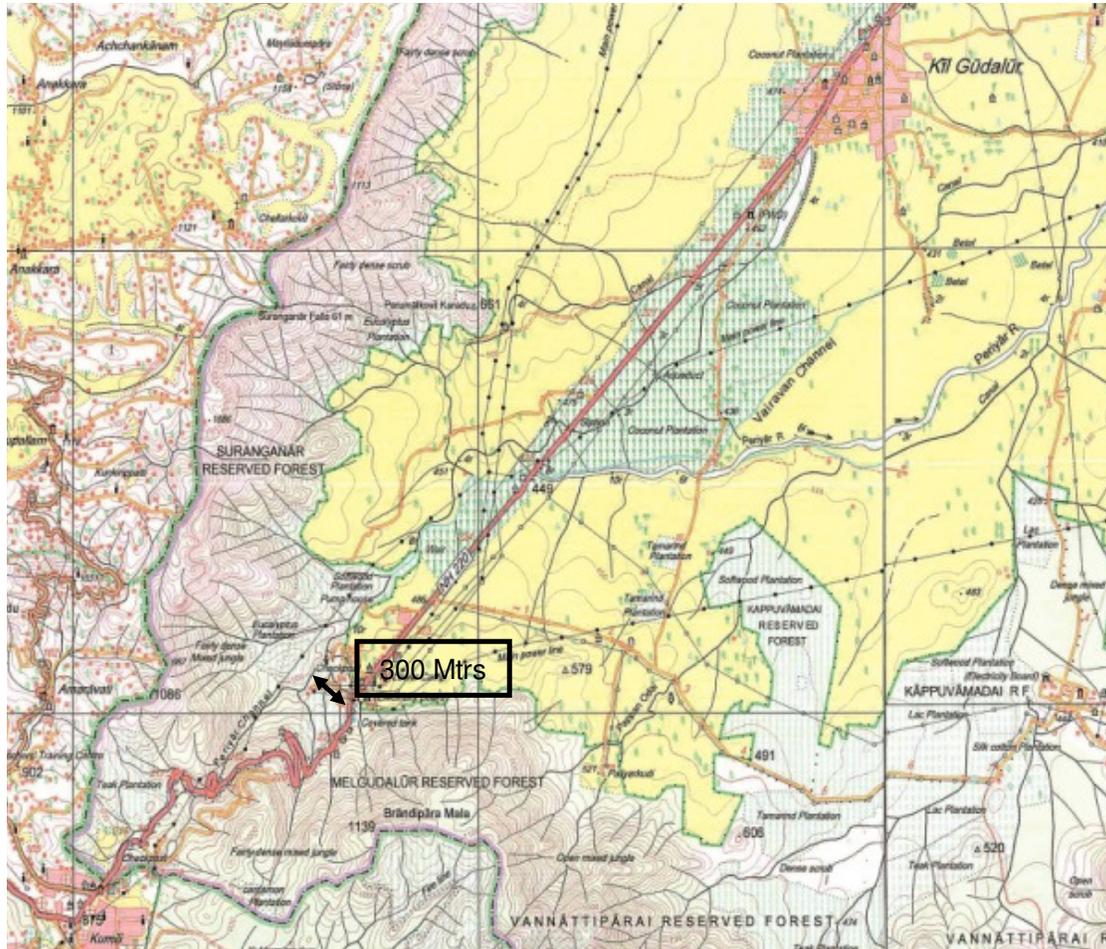
F. CONCLUSION

- Based on the aforementioned details provided, it can be reasonably inferred that aspect of dam safety, has been adequately considered by the Honorable Supreme Court (S.C.) while arriving at its order dated May 07, 2014.
- As per directions of the Honorable Supreme Court of India, Government of India has subsequently constituted the Supervisory Committee with defined structure, roles and responsibilities to carry out periodic inspections and recommend safety and strengthening measures as required¹⁵.
- Further, S.C. Order dated May 07, 2014 also highlights the need for water for irrigation and drinking requirements of the drought prone five districts in Tamil Nadu. (Madurai included) which can be met through the ordered increase of the FRL.

¹⁴ Government of India, Ministry of Water Resources, River Development & Ganga Rejuvenation (Peninsular River Wing), Office Memorandum No.R16011/6/2014 – Pen. River/ 47 dated 01 July 2014,

¹⁵ Supervisory Committee has resolved to locate the office at Kumily, Kerala. Six meetings of the Supervisory Committee on Mullaperiyar Dam have already been held as specified in S. No.14, Ref. URL: <http://mowr.gov.in/acts-tribunals/other-inter-state-water-disputes/mulla-periyar-dam-issue>.

Appendix 13: Map Showing the Distance from Forest Area and Proposed Project



Appendix 14: Existing Water Supply System

1. Water Supply and Sewerage System: The Madurai Municipal Corporation Water Supply is vested with the responsibility of

- Promoting and securing the planned development of water supply and sewerage services, creation, operation and maintenance of the needed infrastructure and
- Implementation of perspective plans to meet both current and future requirements in the areas falling under the city limit.

2. Sources of Water for Madurai City. The Madurai Corporation supplies water to the Core city from Vaigai Dam and sub- surface water supply schemes on Vaigai River.

Table 1: Treatment capacity of water treatment plant

| S. No. | Name of Source/Scheme | Type of Source | Present Supply (MLD) | Remarks |
|-----------------------------------|---------------------------|----------------------------------|----------------------|--------------------------------|
| Scheme-I | | | | |
| 1 | Kochadai | Infiltration Galleries | 8.46 | Sub-Surface Water/Ground Water |
| 2 | Kochadai | Collector Well | | Not Functioning |
| 3 | Thachampathu Melakkal WSS | Infiltration Galleries | 14 | Sub-Surface Water/Ground Water |
| Scheme-II | | | | |
| 4 | Manalur and Thiruppuvanam | Collector Wells | 7 | Sub-Surface Water/Ground Water |
| Vaigai Water Supply Scheme | | | | |
| 5 | Vaigai WSS, Line-I | Intake Well Vaigai Dam | 68 | Surface Water |
| 6 | Vaigai WSS, Line-II | Intake Well Vaigai Dam | 47 | Surface Water |
| Scheme-III | | | | |
| 7 | Vaigai River bed Sources | Infiltration wells | 17.54 | Sub-Surface Water/Ground Water |
| Scheme-IV | | | | |
| 8 | Melur CWSS | Collector Wells in River Cauvery | 30 | Sub-Surface Water/Ground Water |
| | Total | | 192 | -- |

Table 2: Storage capacity of reservoirs supplying water to Madurai

| S. No. | Service Reservoir | Storage Capacity (in Lakh Litre) |
|---------------|---|---|
| 1 | Sengol Nagar (CAS Colony), Vilangudi | 10 |
| 2 | Sellur Kanmai – Composting yard Sector 6 | 25 |
| 3 | Sellur Lorry Stand | 15 |
| 4 | Kattabomman Nagar (Sivagami Street) | 15 |
| 5 | Rajaji Park | 15 |
| 6 | SMP Colony near Mayor Bungalow (MPS site) | 15 |
| 7 | KK Nagar (Central Veg. Market) | 5 |
| 8 | Zamburopuram market (Valavanthan Park) | 15 |
| 9 | Surveyor colony (Near Mahatma school) Anandaraj nagar | 15 |
| 10 | Arappalayam Two wheeler Parking | 25 |
| 11 | Arasaradi back side of Pumping station | 25 |
| 12 | VKP Nagar Madakulam | 20 |
| 13 | Kochadai back side of Pumping station | 20 |
| 14 | TVS Park Sathya sai Nagar | 25 |
| 15 | TVS Park Sathya sai Nagar | 20 |
| 16 | Muthupatti Nagar near PS | 20 |
| 17 | Thideer Nagar | 20 |
| 18 | Thideer Nagar | 25 |
| 19 | Vaalaitoppu Corporation Ground | 25 |
| 20 | AVSS Hospital behind MPS Santhaipeetai | 25 |
| 21 | Meenakshi Nagar | 20 |
| 22 | Slaughter House | 15 |
| 23 | Muniyandi Kovil street (Ward 100,75) | 2 |
| 24 | Muthuramalinga Puram Bykara | 5 |
| 25 | Semparuthi Nagar –NZ1 | 15 |
| 26 | Mudakkathan –N24 | 10 |
| 27 | Alangkulam Lake –N24A | 10 |

| S. No. | Service Reservoir | Storage Capacity (in Lakh Litre) |
|---------------|------------------------------------|---|
| 28 | Anaiyur – NZ3 | 10 |
| 29 | Indranagar – NZ2 | 10 |
| 30 | Park Town – NZ5 | 10 |
| 31 | Thiruppalai – NZ7A (Chakra Nagar) | 5 |
| 32 | EB Colony – NZ7 | 10 |
| 33 | Naganakulam – NZ6 (Ward – 49) | 10 |
| 34 | Bharath Nagar | 10 |
| 35 | Island Nagar – NZ8 (Ward – 48) | 10 |
| 36 | GR Nagar – NZ9 | 10 |
| 37 | Poriyalar Nagar | 5 |
| 38 | Shenpagathottam – NZ 14 | 15 |
| 39 | Shenpagathottam – NZ15 | 15 |
| 40 | Iravathanallur – SZ1 | 5 |
| 41 | Chinna Anuppanadi –SZ2 | 10 |
| 42 | Gurunathar Koil – SZ3(Chinntamani) | 10 |
| 43 | MMC Colony – SZ 5 | 10 |
| 44 | MMC Colony –SZ4 | 10 |
| 45 | Villapuram – SZ6(Ward – 61) | 10 |
| 46 | Semppoorani – SZ7 | 10 |
| 47 | Vellakkal – SZ8 | 15 |
| 48 | Harvipatti – SZ10 | 10 |
| 49 | Kurinchi Nagar – SZ11(Thirunagar) | 5 |
| 50 | Balaji Nagar – SZ12 | 5 |
| 51 | Moolakarai Sump – SZ9 | 2 |
| 52 | Pasumalai – SZ13 | 5 |
| 53 | Ulaganeri – NZ 11(Ward – 28) | 10 |
| 54 | Pandian Nagar – NZ12 | 10 |
| 55 | Pandian Nagar – NZ 13 | 15 |
| 56 | Kadachanendhal - Ward 26 | 2 |
| | Total | 721 |

Table 3: Quality Standards of Raw Water and Treated Water

| S. No. | Parameters | Raw Water Range | Treated water range |
|--------|-------------------|-----------------|---------------------|
| 1 | pH | 7.5 | 7.1 |
| 2 | TDS | 154 | 159 |
| 3 | Turbidity | 6.0 | 0.4 |
| 4 | Total Hardness | 96 | 90 |
| 5 | Total Alkalinity | 90 | 86 |
| 6 | Total Chloride | 16 | 19 |
| 7 | Residual Chlorine | 1.6 | 6.2 |
| 8 | Sulphates | 7 | 3 |
| 9 | Iron | Nil | Nil |
| 10 | Fluorides | Nil | Nil |

Improvements Made

Under JnNURM funds, three numbers of check dams were constructed in River Vaigai at the following locations:

- 1) Melakkal -To recharge the wells near Melakkal and Thatchampathu.
- 2) Kochadai - To recharge the wells & Gallery in Kochadai.
- 3) Thiruppuvanam - To recharge the collector wells in Manalur & Thiruppuvanam.

Vaigai Water Supply Scheme

In this scheme intake well is located about 1.5 km downstream of Vaigai dam on the Vaigai River near Pickup weir. Full yield / supply throughout the year can be obtained through the scheme. This scheme was implemented as Line-I and Line-II in the year 1995 and 2009 respectively. Line-I, having design capacity of 68 MLD, supplies water to the south of River Vaigai (51 Wards) and Line-II with design capacity of 47.00 MLD supplies water to North of River Vaigai (21 Wards) of the Core City Madurai Municipal Corporation. The Corporation is getting about 115 MLD water from the scheme. Schematic of this scheme is shown below



Vaigai Dam



Existing Intake Wells



Collection Well cum Inspection Tower



b) View of the Cascade Aerator

Madurai Corporation is mainly depending on Vaigai Dam surface water as source for its drinking water supply needs. As per the Government Order 1500 MCFT /year of water from Vaigai Dam is allotted to Madurai Corporation for Drinking water supply purpose. The complete quantity of 1500 MCFT / year is now drawn from Vaigai Dam through pipe lines.

Transmission Mains

Raw water from scheme Line - I & Line - II for Vaigai WSS from Vaigai Dam are conveyed to the WTP at Pannaipatti by gravity, through 1100mm PSC transmission main for a length of 16.60 km. Similar to the existing scheme, for the proposed third water supply scheme, raw water from Vaigai Dam is conveyed to the proposed WTP at Pannaipatti through 1067 mm X 8.8 mm thick MS pipes for a length of 16.85 km.

In the second water supply scheme, for conveying 47 MLD 1100 mm PSC pipes were designed and executed similar to the first water supply scheme of capacity 71.6 MLD with the hope of getting additional quantity of water from Vaigai Dam. In the above pipe line some leaks were observed in the alignment and the raw water is allowed to bypass the aerator to reduce the number of leaks and to improve the drawal. In the raw water alignment, people who involved in agricultural field, try to tamper the valves and joints when the monsoon fails.

Water Treatment Plant

The existing water treatment plant for Madurai Municipal Corporation was commissioned in the year of 1995 at Pannaipatti village located 16.60 km away from Vaigai reservoir. The capacity of WTP is 118.6MLD (71.60MLD for Line-I & 47.00 MLD for Line-II). The treatment facility is based on the conventional system comprising Aeration, Clariflocculation and Rapid Sand Filtration. The details of Water Treatment Plant are shown below:



Existing WTP



c) Existing Filter Beds

Table 4: Details of Water Treatment Plant

| S. No. | Components | Description |
|-----------|------------------------------|--|
| I | Water Treatment Plant | |
| 1 | Components | Cascade Aerator – 2 No (10 m Dia Collection tray) |
| | | Stilling Basin -2 (6x4x3.3m) |
| | | Dividing Well – 6m Dia |
| | | Flash Mixer – 4 No's – 3.8 m Dia,4.05m depth |
| | | Clariflocculator -2 no's (with Tube Settlers) |
| | | Rapid Sand Filter Beds -12 No's (4mx6m) (Dual Media Filters) |
| | | Clear water sump -30 LL and 35 m Dia |
| 2 | Capacity of WTP | 118.6 MLD |
| II | Clear Water Reservoir | |
| 1 | Capacity | 30 Lakh Litres |
| 2 | Diameter of Sump | 35 m |
| 3 | Depth of Sump | 2.4 m |

A critical component in the water supply improvement scheme is the treatment of surface water drawn from Vaigai Dam Reservoir through installation of water treatment facility. Madurai Corporation has been allotted 1,500 MCFT / year of water for drinking purposes. Out of this allotment, 900 MCFT / year is being drawn through raw water gravity main and treated at a full scale of 71.60 MLD Water Treatment Plant at Pannaipatti installed as part of a World Bank project in the year 1995.

For the treatment of 600 MCFT/year (47MLD) of water, the already functioning Treatment plant of capacity 71.6 MLD was upgraded to 118.6 MLD by introducing tube settlers in the existing Clariflocculators and by providing dual media with anthracite coal as filter media in addition to the sand in the existing filter beds. The treatment plant is now capable of handling 118.6 MLD of raw water

Clear Water Transmission Main

The clear water from Pannaipatti WTP is conveyed to Arasaradi pumping station and also for few service reservoirs by gravity and then water is distributed to different service reservoirs from the pumping station. Clear water is transmitted to main pumping station (Booster pumping station) by gravity, through 48.80km along 1100mm Φ and 1000mm Φ PSC mains under Line – I and Line – II respectively. details of clear water transmission main for Madurai Municipal Corporation laid under Vaigai scheme (Line – I and Line – II) is given.

Table 5: Details of Clear Water Transmission Mains

| S. No. | Components | Description Line-I | Description Line-II |
|--------|-----------------------------------|---------------------------------|---------------------|
| 1 | Type of main | Gravity main | Gravity main |
| 2 | From | Pannaipatti WTP | Pannaipatti WTP |
| 3 | To | Madurai Corporation (Arasaradi) | Madurai Corporation |
| 4 | Dia (mm) | 1100 | 1000/900/800 |
| 5 | Length (km) | 48.8 | 48.8 |
| 6 | Capacity (MLD) | 68 | 47 |
| 7 | Material | PSC | PSC/GRP |
| 8 | Break pressure tank (lakh litres) | 5.0 | 5.0 |
| 9 | Year of laying | 1995 | 2009 |

Pumping Machinery

The details of pumping machinery from source to distribution are presented in the following Tables.

Table 6: Details of Pumping Machinery at Source

| S.No | Location of Pumps | YOC | Pumps/Motors | No's | Age(Years) |
|------|---------------------------------|------|--------------|------|------------|
| 1 | Kochadai WSS-I | 1924 | 170HP | 2 | >40 |
| 2 | Kochadai WSS-I (Collector Well) | 1963 | 135HP | 23 | >40 |
| 3 | Melakal WSS | 1963 | 60HP | 2 | 47 |
| 4 | Manalur and Thirupuvanam WSS | 1983 | 25HP | 2 | 20 |
| | | 1983 | 40HP | 2 | 20 |
| | | 1983 | 230HP | 2 | 20 |
| 5 | Thachampattu | 1983 | 7.5HP | 6 | 5 |

Table 7: Details of Pumping Machinery at Booster Station

| S. No. | Location | Particulars | No's | Motor Details | Pump Details | |
|--------|---------------------------|--------------------------------|-------|---------------|-----------------------|---------------|
| | | | | | Rated Discharge (LPM) | Rated Head(m) |
| 1 | Arasaradi Booster Station | South Zone Feeder | 1W+1S | 120HP | 10896 | 24 |
| 2 | Arasaradi Booster Station | North Zone Feeder | 1W+1S | 150HP | 9500 | 49 |
| 3 | Arasaradi Booster Station | North Zone Feeder (VWS Scheme) | 1W+1S | 270HP | 19000 | 49 |

Service Reservoirs

The Water from Vaigai Dam Reservoir is supplied to North and South zones of Madurai city. The northern part of Madurai i.e., the area above the Vaigai River is called North zone and the area below Vaigai River is called South zone. The entire distribution system is divided in to 28 zones. The North zone is divided in to 12 water distribution zones and whereas the South zone consist of 16 distribution zones. The water supply for the city is getting potable water from 28 numbers of water reservoir/OHT's having different capacities. The total storage capacity of the OHT's is 394.5 LL and the details of service reservoirs are given in the Table 8.

Table 8: Details of Existing Service Reservoirs

| S. No. | Name of the OHT | Capacity (LL) | Year of Const. | MWL (m) | LWL (m) | Avg. GL (m) | Staging Height (m) |
|---|----------------------|---------------|----------------|---------|---------|-------------|--------------------|
| North of River Vaigai (21 Wards) | | | | | | | |
| 1 | Aruldasapuram | 20.00 | 1992 | 161.20 | 157.20 | 143.20 | 14 |
| 2 | Sellur | 13.60 | 1975 | 158.10 | 154.10 | 142.60 | 12 |
| 3 | Rajaji Park | 18.16 | 1975 | 155.50 | 151.50 | 139.60 | 12 |
| 4 | Anna Nagar – I | 2.30 | 1975 | 150.43 | 146.43 | 134.43 | 12 |
| 5 | Anna Nagar – II | 6.00 | 1992 | 150.43 | 146.43 | 134.43 | 12 |
| 6 | K.K. Nagar | 8.00 | 1992 | 155.1 | 152.10 | 140.10 | 12 |
| 7 | Lotus Tank | 1.00 | 1990 | 150.8 | 147.8 | 140.3 | 12 |
| 8 | K. Pudur | 15.00 | 1975 | 156.02 | 152.02 | 140.02 | 12 |
| 9 | Race Course | 6.80 | 1975 | 158.5 | 154.5 | 142.5 | 12 |
| 10 | Reserve Line | 20.00 | 1992 | 168.20 | 164.2 | 146.20 | 18 |
| 11 | Maruthankulam | 5.00 | 2005 | 159.60 | 156.10 | 140.10 | 16 |
| 12 | P&T Nagar | 10.0 | 2005 | 170.12 | 166.12 | 150.12 | 16 |
| | Total Storage | 126.00 | | | | | |
| South of River Vaigai (51 Wards) | | | | | | | |
| 1 | Kochadai | 15.00 | 1992 | 157.62 | 153.62 | 138.62 | 15.00 |
| 2 | Palanganatham | 25.00 | 1992 | 153.50 | 149.40 | 134.40 | 15.00 |
| 3 | Arapalayam | 30.00 | 1992 | 158.00 | 154.00 | 134.68 | 19.30 |

| S. No. | Name of the OHT | Capacity (LL) | Year of Const. | MWL (m) | LWL (m) | Avg. GL (m) | Staging Height (m) |
|--------|----------------------|---------------|----------------|---------|---------|-------------|--------------------|
| 4 | Sunday Market I | 10.00 | 1992 | 149.17 | 145.67 | 131.67 | 14.00 |
| 5 | Sunday Market II | 10.00 | 1992 | 149.17 | 145.67 | 131.67 | 14.00 |
| 6 | Tamil Sangam Road | 20.00 | 1992 | 151.67 | 147.67 | 132.67 | 15.00 |
| 7 | East Marret Street | 20.00 | 1992 | 150.00 | 146.00 | 131.37 | 14.60 |
| 8 | Traveler's Bungalow | 30.00 | 1992 | 154.00 | 150.00 | 131.50 | 18.50 |
| 9 | Joseph Park I | 15.00 | 1975 | 153.50 | 149.50 | 129.50 | 20.00 |
| 10 | Joseph Park II | 15.00 | 1992 | 153.00 | 149.00 | 129.50 | 19.50 |
| 11 | New Ramnad Road | 15.00 | 1992 | 147.90 | 143.90 | 129.90 | 14.00 |
| 12 | Jhansi Rani Park | 20.00 | 1975 | 156.00 | 152.00 | 137.00 | 15.00 |
| 13 | Arasaradi | 11.50 | 1975 | 150.40 | 146.40 | 136.35 | 10.05 |
| 14 | H.M.S.Colony | 16.00 | 2005 | 165.19 | 161.19 | 145.19 | 16 |
| 15 | Sundararajapuram | 16.00 | 2005 | 160.05 | 156.05 | 140.05 | 16 |
| 16 | Keeraithurai | 16.00 | 2005 | 157.01 | 153.01 | 137.01 | 16 |
| | Total Storage | 284.50 | | | | | |

Water Distribution System

The potable water supply network covers about 59% of the households in the Madurai Municipal Corporation. The existing water supply consists of about 764km long pressurized pipe network. The distribution system in Madurai Municipal Corporation consist of CI, AC, PVC and PSC pipes with diameter varies from 63mm to 150mm and 1/2inch house service connections are provided to all legal connections. The condition of the pipes in certain areas (core area of the city) is reported to be poor and the carrying capacity reduced due to deposits (incrustation) especially in CI pipes. This may lead to incrustation, friction losses and loss of pressure at the tail end of the distribution network.

House Service Connections:

The details of the house service connection are given in the Table 9.

Table 9: Details of House Service Connection

| S. No. | Type of Connection | No. of Connection |
|--------|--------------------|-------------------|
| 1 | Domestic | 94,487 |
| 2 | Non-Domestic | 600 |
| 3 | Commercial | 400 |
| | Total | 95,487 |

B. O&M of the Existing Distribution System

The Madurai Municipal Corporation does the O&M of Water distribution system. Regular records for the valve operations, water levels in towers, water quality are maintained and inlet–outlet meter management are done by this department.

One of the major problems reported in the distribution system is un-equitable supply of water to different parts of a distribution zone. It is observed that the distribution system for a length of about 490Km is more than 30 to 40 years old and these pipes are with incrustations

resulting friction and reduction in pressure and flow and also they are very susceptible to damage. It is proposed to revamp the existing distribution system as well as new distribution system for the newly encompassed area (the newly encompassed area not having integrated distribution system).

Water Tariff Structure

The monthly water tariff for domestic house service connection, non-domestic connection as well as for commercial connections is charged on a flat rate as follows.

Table 10: Details of Water Tariff

| S. No. | Type of Connection | Monthly Charges | Deposit Charges (Rs.) | Connection Charges (Rs.) |
|---------------|----------------------------|------------------------|------------------------------|---------------------------------|
| 1 | Domestic | 42.85 | 1000 | 1500 |
| 2 | Non-Domestic/ Intuitionial | 85 | 2000 | 2000 |
| 3 | Commercial/ Industrial | 150 | 4000 | 2500 |

Appendix 15: OHT Details

| OHT No | Location Name | Ward name/no. | Land detail Khasra no | Classification | Ownership department | Area available | Area required | North, South, East, West side bounded details |
|--------|---|---------------|--------------------------|-----------------------|----------------------|----------------|---------------|--|
| 1. | Sengol Nagar (CAS Colony), Vilangudi | 8 | TS 137/1 | Side of Burial Ground | MMC | 4234 | 400 | N – Residential E – Vacant W – Channel S – Vaigai River |
| 2. | Sellur Kanmai – Composting yard Sector 6 | 37 | RS 101 to 105 | Side of Compost Yard | MMC | 4089 | 900 | N – Vacant Area E – Vacant Area W – Vacant Area S – Vacant Area |
| 3. | Sellur Lorry Stand | 37 | TS No. 1382/2(P) | Corp Lorry Stand | MMC | 1000 | 625 | N – Lorry Stand E – Institution W – Residential S – Vaigai River |
| 4. | Kattabomman Nagar (Sivagami Street) | 41 | TS No. 3865 | Vacant Site | MMC | 1960 | 529 | N – Residential E – Residential W – Residential S – Residential |
| 5. | Rajaji Park | 43 | TS No. 4 | Existing Park | MMC | 2912 | 928 | N – Existing OHT E – Park W – Corporation Quarters S – Corporation Quarters |
| 6. | SMP Colony near Mayor Bungalow (MPS site) | 33 | TS No. 38/7 to 15 | Vacant Site | MMC | 5026 | 500 | N – Residential E – Exist Sewage Sump W – Residential S – Vaigai River |
| 7. | KK Nagar (Central Veg. Market) | 44 | TS No. 2236, 2737, 11/10 | Vacant Site | MMC | 3862 | 225 | N – Vacant Area E – Market W – Petrol Bunk S – Residential |
| 8. | Zamburopuram market (Valavanthan Park) | 41 | -- | -- | MMC | | | N – Residential E – Residential W – Commercial Building S – Residential |

| OHT No | Location Name | Ward name/no. | Land detail Khasra no | Classification | Ownership department | Area available | Area required | North, South, East, West side bounded details |
|--------|---|---------------|-----------------------|----------------|----------------------|----------------|---------------|---|
| 9. | Surveyor colony (Near Mahatma school) Anandaraj nagar | 27 | -- | Vacant Site | MMC | | | N – Residential E – Residential W – Sathaiyar River S – Sathaiyar River |
| 10. | Arappalayam Two wheeler Parking | 15 | TS No. 970 | Vacant Site | MMC | 1814 | 900 | N – Vaigai River E – Existing OHT W – Vaigai River S – Residential |
| 11. | Arasaradi back side of Pumping station | 14 | V/TS No. 5 13040-01B2 | Vacant Site | MMC | 2091 | 900 | N – Chinthamani Channel E – Residential W – Residential S – Existing Pumping Station |
| 12. | VKP Nagar Madakulam | 75 | TS No. 16/14 | Vacant Site | MMC | 4500 | 529 | N – Vacant Area E – Vacant Area W – Temple S – Vacant Area |
| 13. | Kochadai back side of Pumping station | 22 | TS No. 1/1V/15 | Vacant Site | MMC | 4800 | 576 | N – Vaigai River E – Vacant Area W – Residential S – Existing OHT |
| 14. | TVS Park Sathya sai Nagar | 77 | TS.No. 88, 89 | TVS Nagar Park | MMC | 4771 | 900 | N – Commercial Building E – Commercial Building W – School S – Industry |
| 15. | TVS Park Sathya sai Nagar | 77 | TS.No. 88, 89 | TVS Nagar Park | MMC | 4771 | 735 | N – Residential E – Commercial Building W – School S – Industry |
| 16. | Muthupatti Nagar near PS | 93 | Rs No. 440/2, 2 | Vacant Site | MMC | 1000 | 529 | N – Existing Pumping Station E – Commercial Building |

| OHT No | Location Name | Ward name/no. | Land detail Khasra no | Classification | Ownership department | Area available | Area required | North, South, East, West side bounded details |
|--------|--|---------------|-----------------------|-----------------------------|----------------------|----------------|---------------|--|
| | | | | | | | | W – Vacant Land S – Residential |
| 17. | Thideer Nagar | | | Vacant Site | MMC | | | N – Residential E – Residential W – Residential S – Residential |
| 18. | Thideer Nagar | | | Vacant Site | MMC | | | N – Residential E – Residential W – Residential S – Residential |
| 19. | Vaalaitoppu Corporation Ground | 69 | TS No. 2597 | Vacant Site | MMC | 2080 | 900 | N – Residential E – Railway Track W – Commercial Building S – Commercial Building |
| 20. | AVSS Hospital behind MPS Santhaipeetai | 52 | TS No. 11, V/17 | Vacant Site | MMC | 5284 | 900 | N – Vaigai River E – Residential W – Corporation Land S – Residential |
| 21. | Meenakshi Nagar | 53, 55 | TS No. 118 | Vacant Site | MMC | 2860 | 750 | N – Vaigai River E – Service Station W – Residential S – Residential |
| 22. | Slaughter House | 57 | TS No. 187/15, 188(P) | Vacant Site | MMC | 2430 | 600 | N – Corp School E – Vacant Area W – Residential S – Residential |
| 23. | Muniyandi Kovil street | 100, 75 | TS No. 482 XXII – 620 | Existing Toilet&Vacant Site | MMC | 1156 | 196 | N – Vacant Area E – Vacant Area W – Temple S – Vacant Area |
| 24. | Muthuramalinga Puram Bykara | 100 | TS No. 35/1A | Vacant Site | MMC | 2236 | 1050 | N – EB Sub Station E – Residential W – Vacant Area |

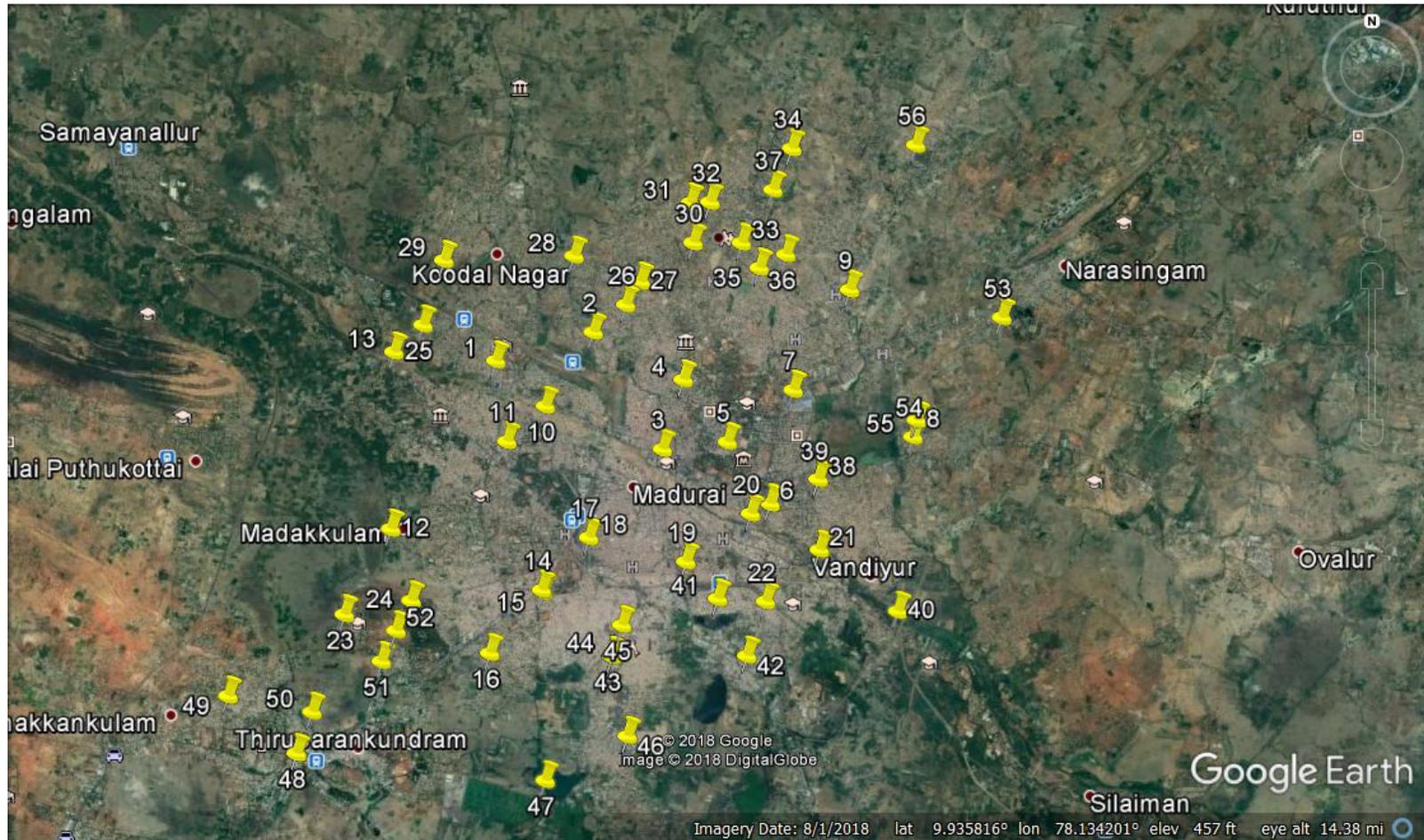
| OHT No | Location Name | Ward name/no. | Land detail Khasra no | Classification | Ownership department | Area available | Area required | North, South, East, West side bounded details |
|--------|----------------------------|---------------|-----------------------|--------------------------|----------------------|----------------|---------------|---|
| | | | | | | | | S – Private Land |
| 25. | Semparuthi Nagar – NZ1 | 8 | TS No. 187/15, 187/6 | Vacant Site | MMC | 2881 | 529 | N – Vacant Area E – Residential W – Residential S – Vacant Area |
| 26. | Mudakkathan –N24 | 5 | TS No. 101 to 105 | Vacant Site | MMC | 1554 | 400 | N – Residential E – Existing OHT W – Residential S – Residential |
| 27. | Alangulam Lake – N24A | 3, 4 | TS No. 7 | Alangulam Kanmai | MMC | 960 | 400 | N – Vacant Area E – Vacant Area W – Residential S – Residential |
| 28. | Anaiyur – NZ3 | 3 | TS No. 64/3 | Vacant Site | MMC | 2120 | 400 | N – Residential E – Vacant Area W – Vacant Area (Water Flow) S – Vacant Area |
| 29. | Indranagar – NZ2 | 23 | Ts No. 73/4, 74/2 | Side of Vilangudi Kanmoi | MMC | 2795 | 400 | N – Industry E – Vacant Area W – Vilangudi Kanmoi S – Vilangudi Kanmoi |
| 30. | Park Town – NZ5 | 5 | TS No. 3865 | Meenakshi Nagar Park | MMC | 1591 | 400 | N – Residential E – Existing OHT W – Residential S – Vacant Area |
| 31. | Thiruppalai (Chakra Nagar) | 24 | TS No. 51/2 | Vacant Site | MMC | 1386 | 196 | N – Residential E – Residential W – Residential S – Residential |
| 32. | EB Colony – NZ7 | 24 | TS No. 79/4 | Vacant Site | MMC | 1088 | 400 | N – Residential E – Vacant Area W – Residential |

| OHT No | Location Name | Ward name/no. | Land detail Khasra no | Classification | Ownership department | Area available | Area required | North, South, East, West side bounded details |
|--------|-------------------------|---------------|--------------------------|-----------------------|----------------------|----------------|---------------|---|
| | | | | | | | | S – Residential |
| 33. | Naganakulam – NZ6 | 49 | TS No. 32 | Vacant Site | MMC | 2040 | 400 | N – Residential E – Existing Sump W – Naganakulam Kanmai S – Residential |
| 34. | Bharath Nagar | 25 | TS No. 132/1 | Vacant Site | MMC | 1657 | 400 | N – Residential E – Residential W – Residential S – Vacant Area |
| 35. | Island Nagar – NZ8 | 48 | TS No. 51/2 | Vacant Site | MMC | 1110 | 400 | N – Residential E – Vacant Area W – Residential & Temple S – Aathikulam Kanmoi |
| 36. | GR Nagar – NZ9 | 25 | RS No. 294/2 | Vacant Site | MMC | 1077 | 920 | N – Existing OHT E – Commercial Building W – Commercial Building S – Residential |
| 37. | Poriyalar Nagar | 25 | TS No. 158 (P)/160 (P) B | Vacant Site | MMC | 1591 | 774 | N – Temple E – Kannanendhal Kanmoi W – Residential S – Residential |
| 38. | Shenpagathottam – NZ 14 | 33, 34 | TS No. 42 | Corp Park | MMC | 3150 | 550 | N – Park E – Residential W – Commercial Building S – Residential |
| 39. | Shenpagathottam – NZ15 | 33, 34 | TS No. 42 | Corp Park | MMC | 3150 | 550 | N – Residential E – Residential W – Residential S – Park |
| 40. | Iravathanallur – SZ1 | 55 | RS No. 5 | Side of Burial Ground | MMC | 1591 | 225 | N – Vaigai River E – Two Wheeler Parking W – Residential S – Burial Ground |

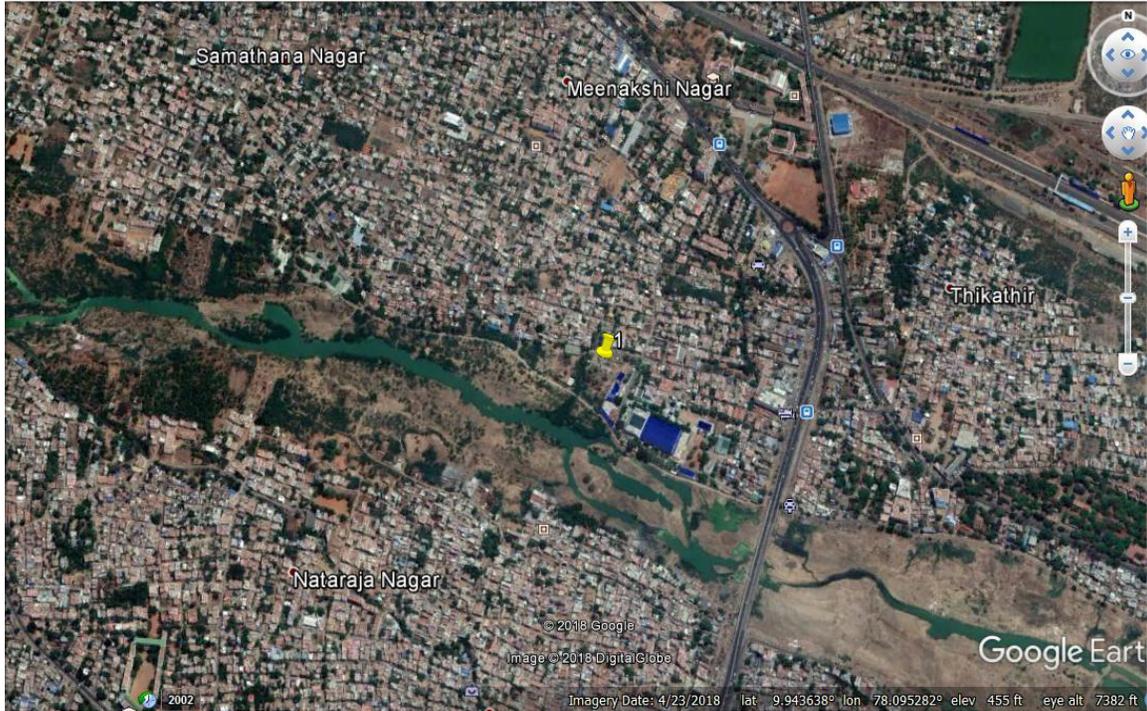
| OHT No | Location Name | Ward name/no. | Land detail Khasra no | Classification | Ownership department | Area available | Area required | North, South, East, West side bounded details |
|--------|-------------------------------------|---------------|-----------------------|---|----------------------|----------------|---------------|--|
| 41. | Chinna Anuppanadi –SZ2 | 56 | RS No. 198 | Vacant Site | MMC | 1470 | 400 | N – Residential E – Vacant Area W – Vacant Area S – Vacant Area |
| 42. | Gurunathar Koil – SZ3 (Chinthamani) | 58 | TS No. 103/1 | Vacant Site | MMC | 1591 | 400 | N – Urban Health Centre E – Vacant Area W – Temple S – Residential |
| 43. | MMC Colony –SZ 5 | 94 | TS No. 386 | Vacant Site | MMC | 19360 | 400 | N – Residential E – Vacant Area W – Proposed OHT S – Vacant Area |
| 44. | MMC Colony –SZ4 | 94 | TS No. 386 | Vacant Site | MMC | 19360 | 400 | N – Residential E – Proposed OHT W – Residential S – Vacant Area |
| 45. | Villapuram – SZ6 (Ward – 61) | 61 | RS No. 411 | Inside of Avaniyapuram WS Pumping Station | MMC | 3957 | 400 | N – Corporation Building E – Residential W – Industry S – Industry |
| 46. | Sempoorani – SZ7 | 60 | RS No. 341 | Vacant Site | MMC | 2151 | 400 | N – Industry E – Residential W – Existing OHT S – Residential |
| 47. | Vellakkal – SZ8 | 94 | TS No. 156 | Vacant Site | MMC | 7400 | 528 | N – Vacant Area E – Vacant Area W – Vacant Area S – Corp Pump Station |
| 48. | Harvipatti – SZ10 | 97 | TS No. 151 | Vacant Site | MMC | 1455 | 400 | N – Park E – Corporation Office W – Residential S – Residential |
| 49. | Kurinchi Nagar – | 98 | TS No. 105, | Vacant Site | MMC | 4080 | 200 | N – Vacant Area |

| OHT No | Location Name | Ward name/no. | Land detail Khasra no | Classification | Ownership department | Area available | Area required | North, South, East, West side bounded details |
|--------|-------------------------------|---------------|---|-----------------|----------------------|----------------|---------------|--|
| | SZ11(Thirunagar) | | 106 | | | | | E – Vacant Area W – Residential S – Residential |
| 50. | Balaji Nagar – SZ12 | 99 | TS No. 120 | Vacant Site | MMC | 2284 | 196 | N – Water Body E – Residential W – Residential S – Residential |
| 51. | Moolakarai Sump – SZ9 | 99 | TS No. 44, 45 | Vacant Site | MMC | 680 | 81 | N – Vacant E – Vacant W – Vacant S – Existing Sump |
| 52. | Pasumalai – SZ13 | 95 | TS No. 22 | Vacant Site | MMC | 1700 | 196 | N – Residential E – Residential W – Residential S – Residential |
| 53. | Ulaganeri – NZ 11 (Ward – 28) | 28 | TS No. 21 | Vacant Site | MMC | 2444 | 900 | N – Residential E – Vacant Area W – Residential S – Water Body |
| 54. | Pandian Nagar – NZ12 | 29 | RS No. 1 (Vandiyur 1 st Pit) | Vacant Site | MMC | 1184 | 400 | N – Residential E – Residential W – Vandiyur Pond S – Vandiyur Pond |
| 55. | Pandian Nagar – NZ 13 | 29 | RS No. 1 (Vandiyur 1 st Pit) | Vacant Site | MMC | 960 | 550 | N – Police Station E – Vandiyur Pond W – Existing Sump S – Water Body |
| 56. | Kadachanendhal - Ward 26 | 27 | TS No. 102/6-1 | Existing Toilet | MMC | 673 | 550 | N – Water Body E – Residential W – Water Body S – Residential |

OHT Locations: (All Sites)



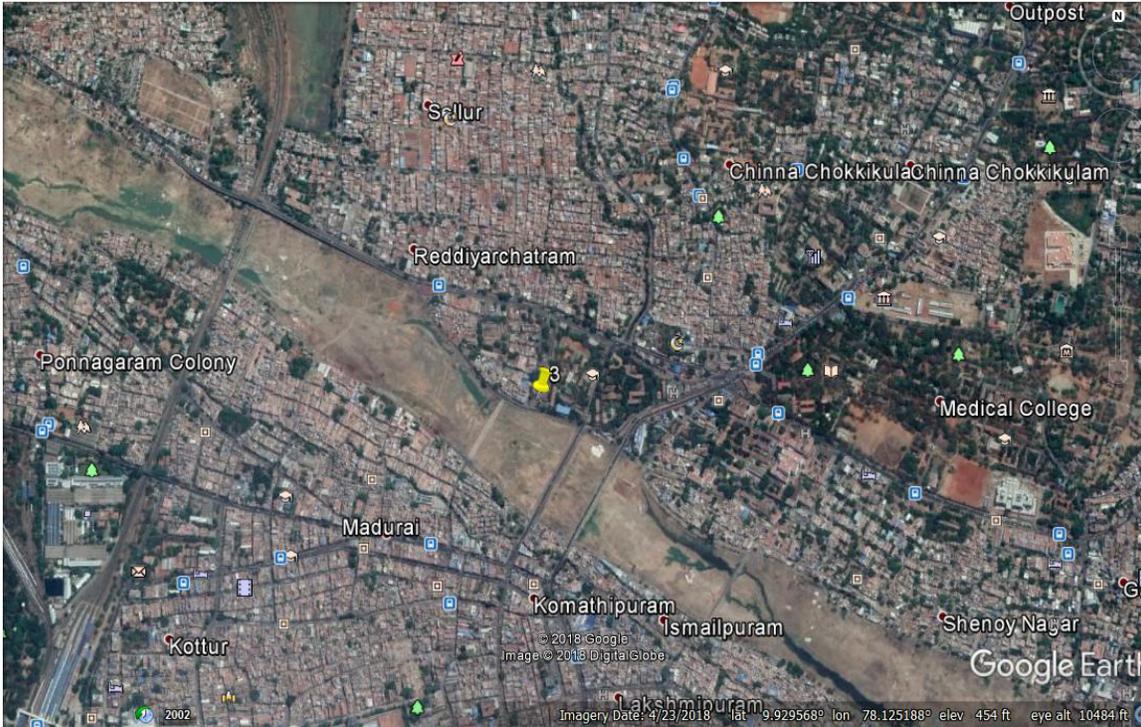
OHT Site Locations:



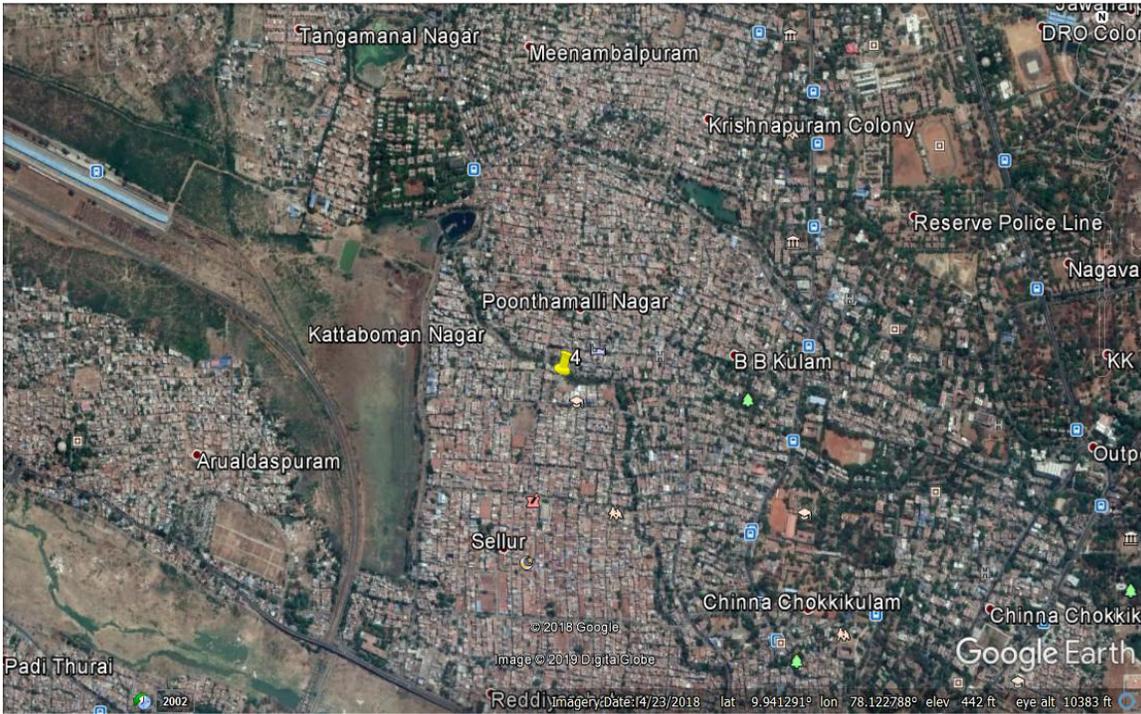
Location No: 1 - Sengol Nagar, Vilangudi



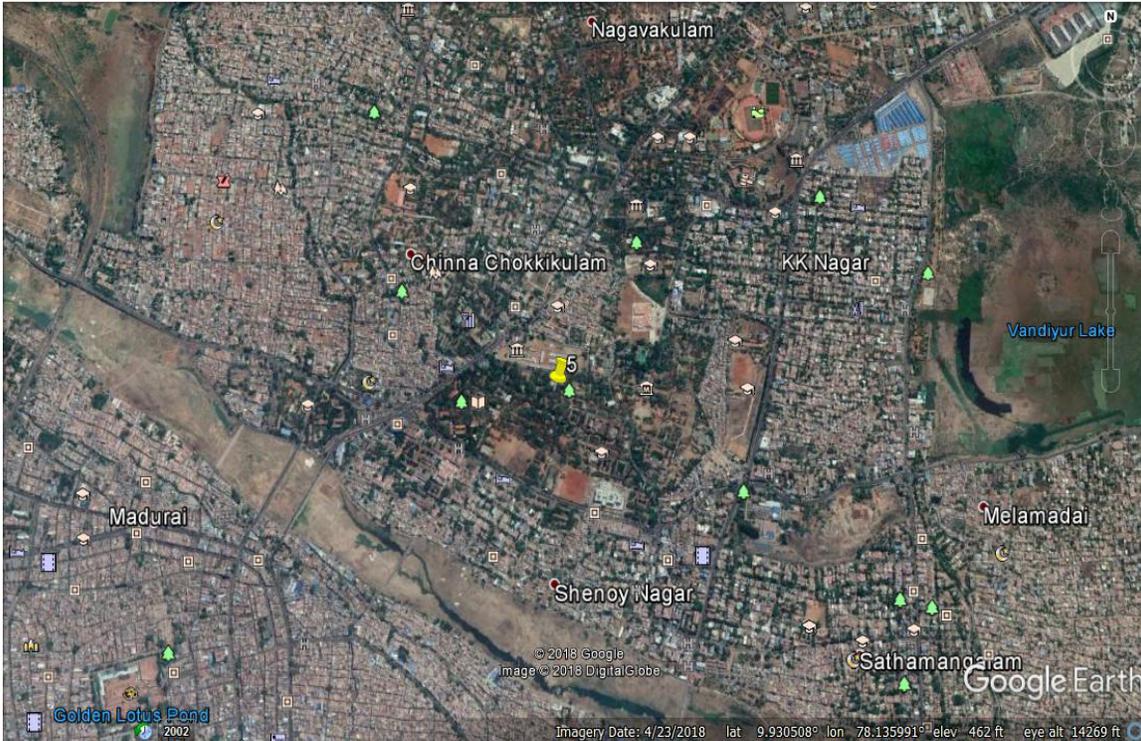
Location No: 2 - Sellur Kanmai



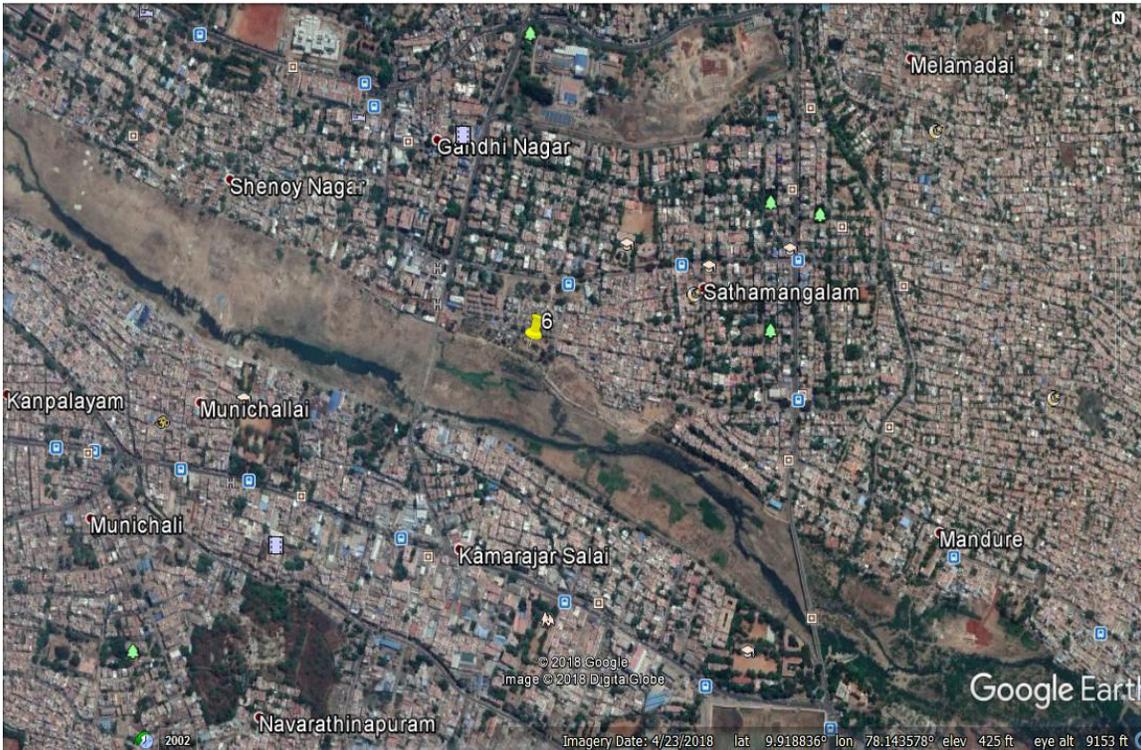
Location No: 3 - Sellur Lorry Stand



Location No: 4 – Kattabomman Street (Sivagami Street)



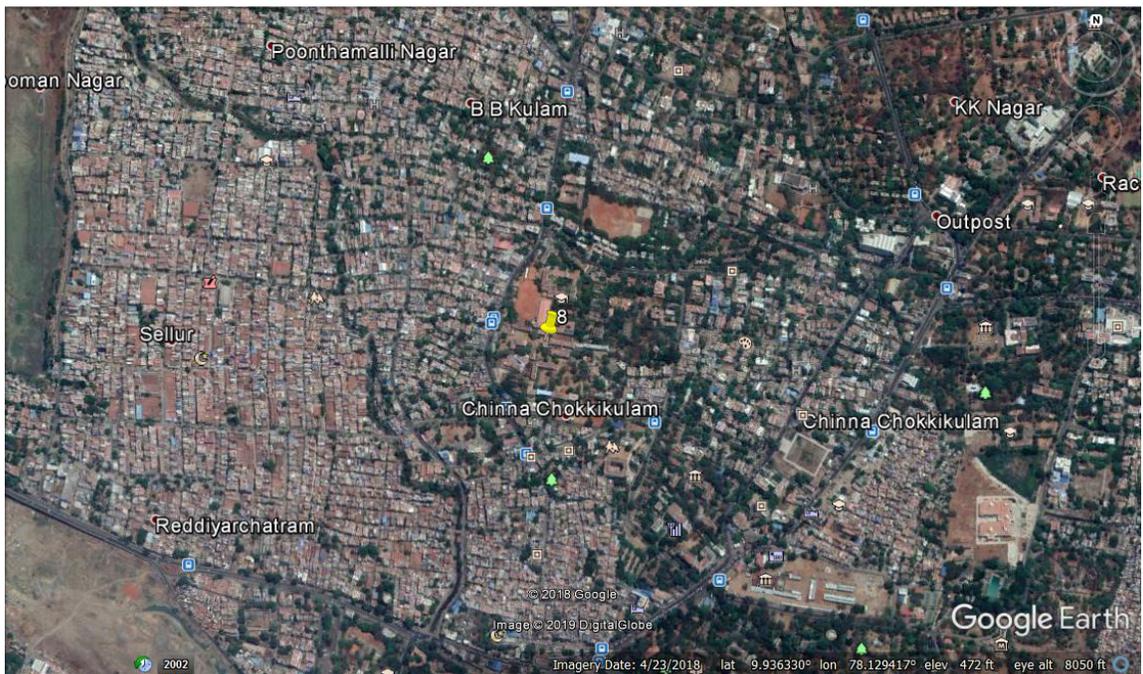
Location No: 5 - Rajaji Park



Location No: 6 - SMP Colony near Mayor Bunglow



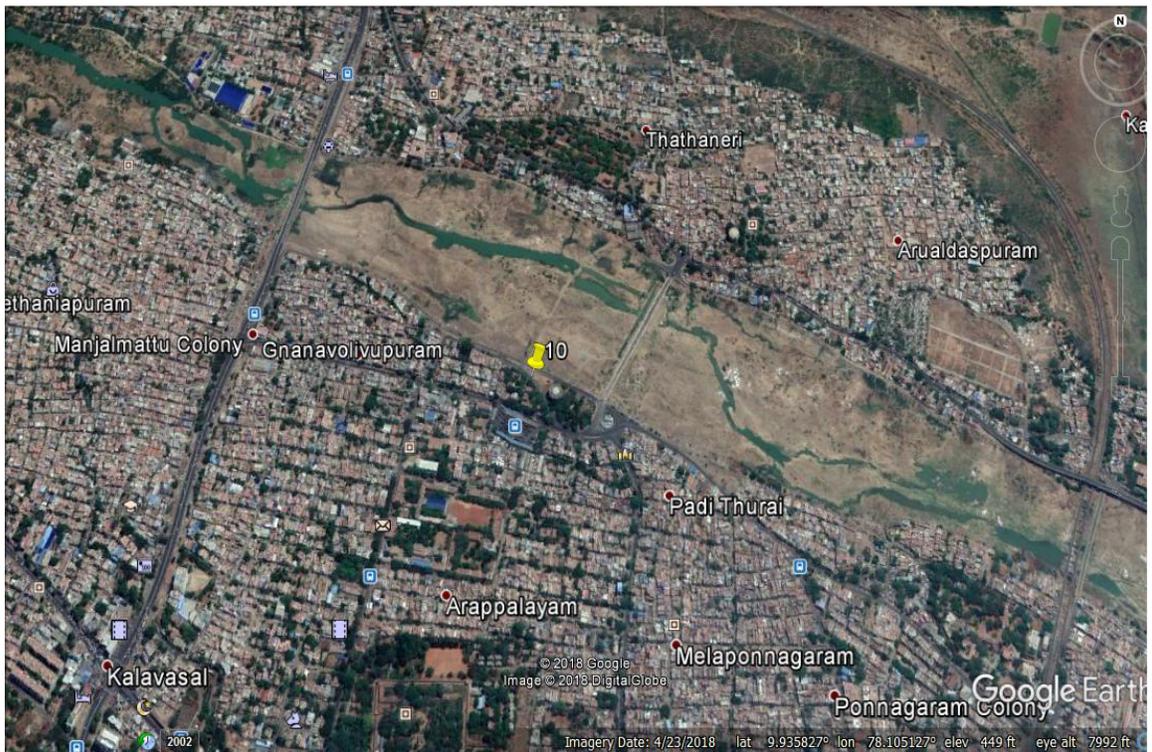
Location No: 7 - KK Nagar (Central Veg. Market)



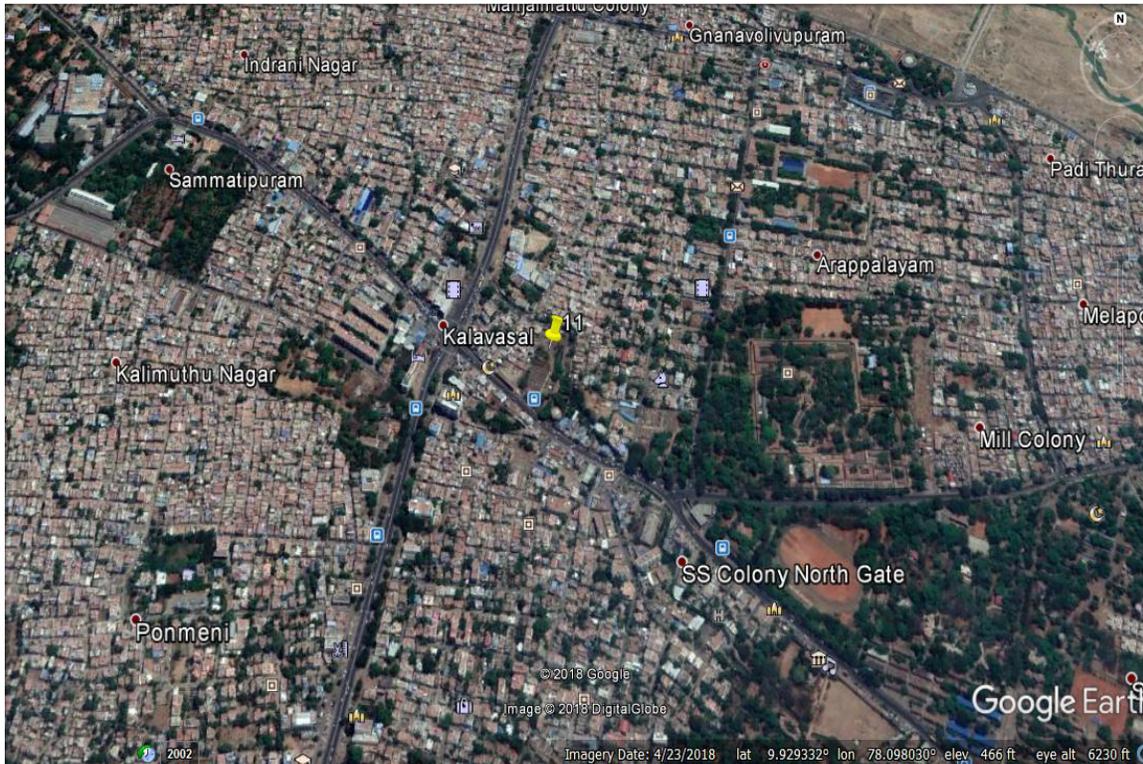
Location No: 8 - Zamburopuram market (Valavanthan Park)



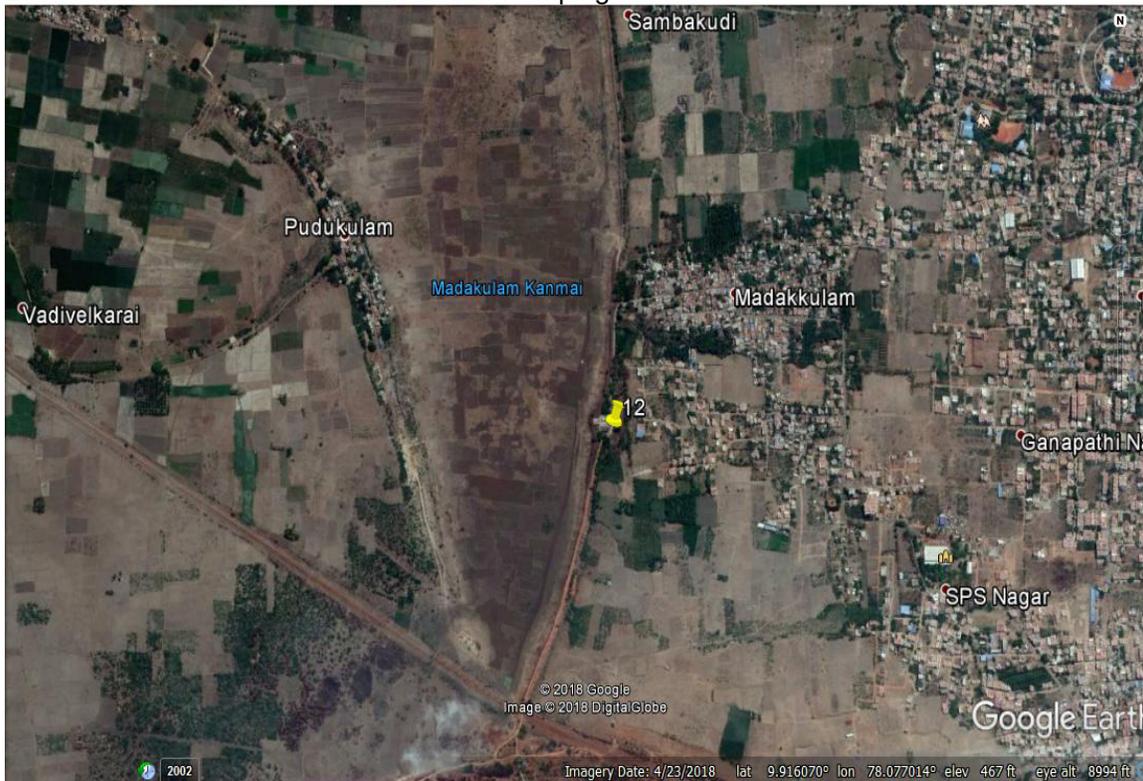
Location No: 9 - Surveyor colony (Near Mahatma school) Anandaraj nagar



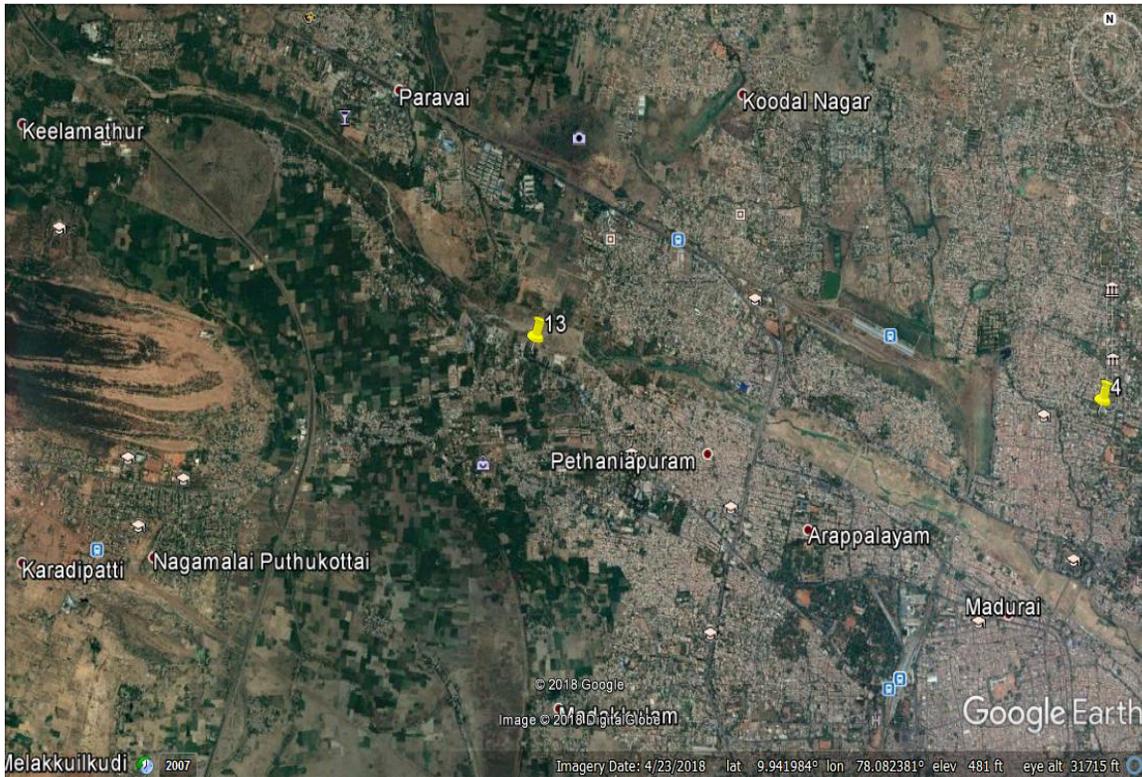
Location No: 10 - Arappalayam Two wheeler Parking



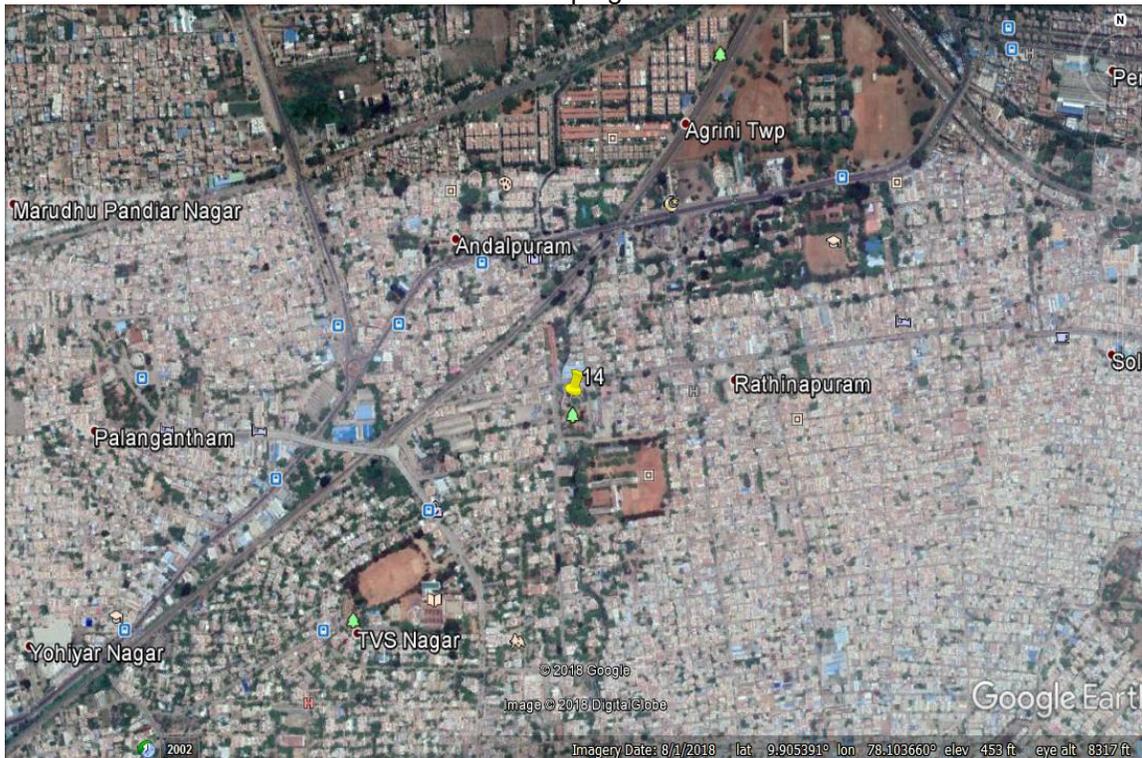
Location No: 11 - Arasaradi back side of Pumping station



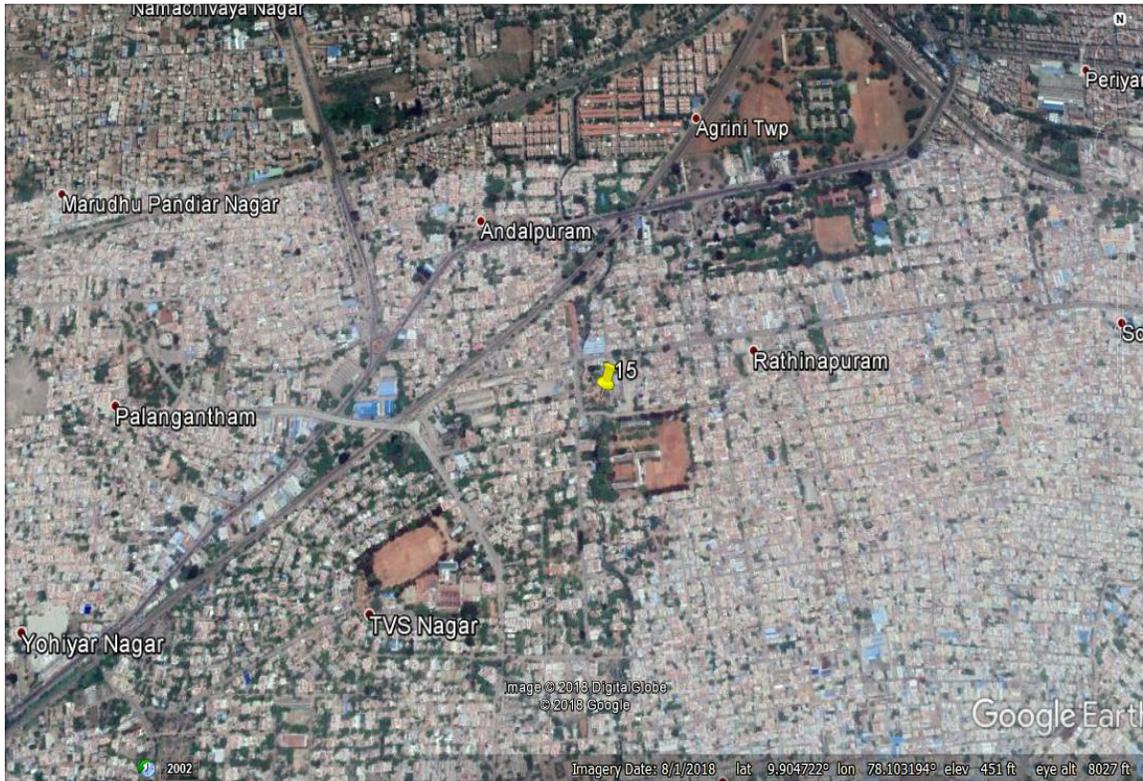
Location No: 12 - VKP Nagar Madakkulam



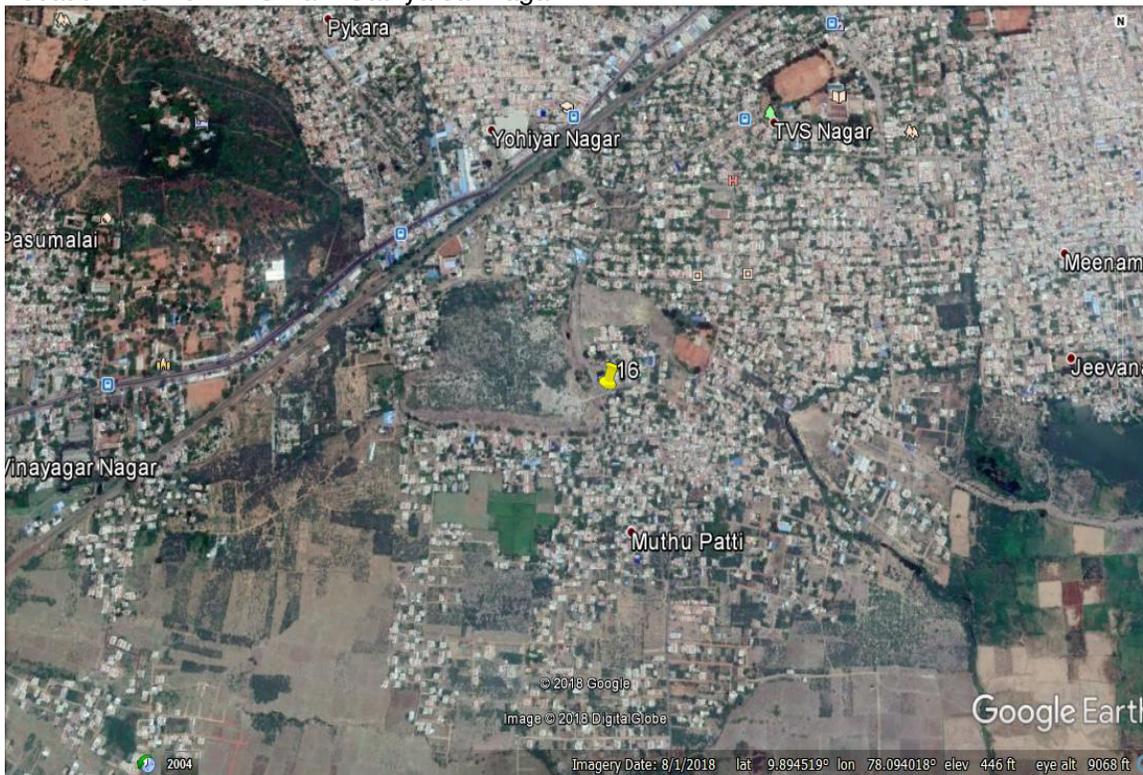
Location No: 13 - Kochadai back side of Pumping station



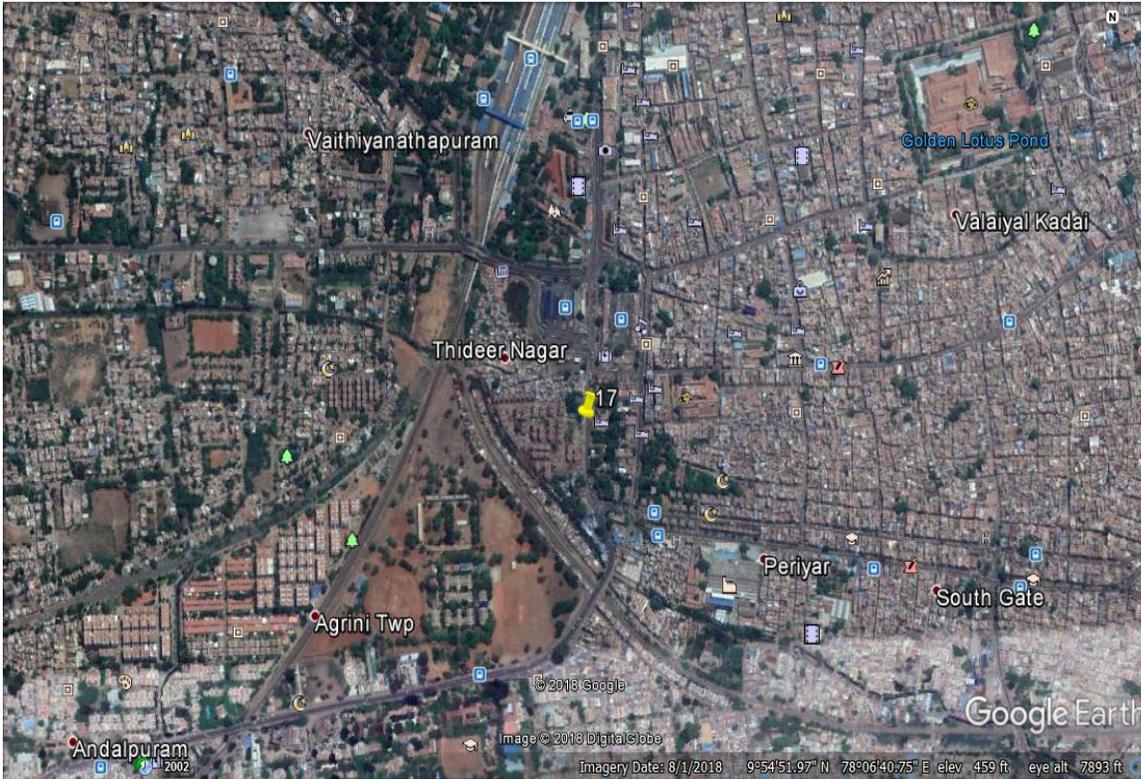
Location No: 14 - TVS Park Sathya sai Nagar



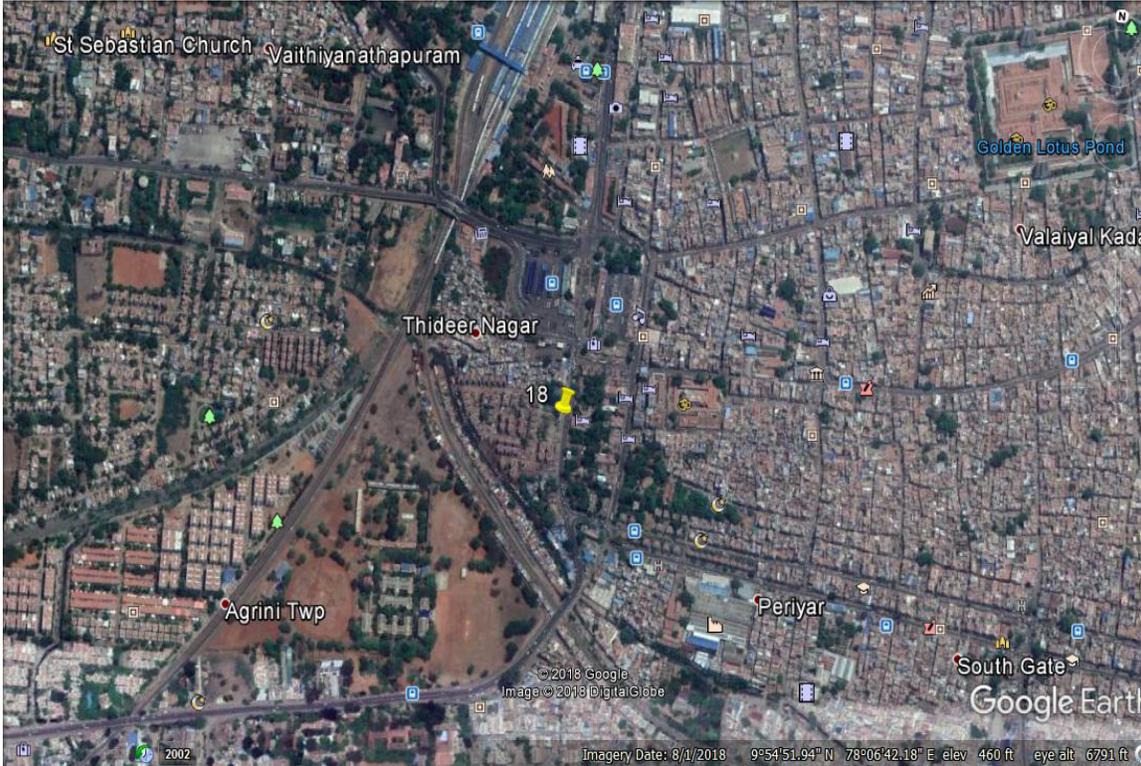
Location No: 15 - TVS Park Sathya sai Nagar



Location No: 16 - Muthupatti Nagar near PS



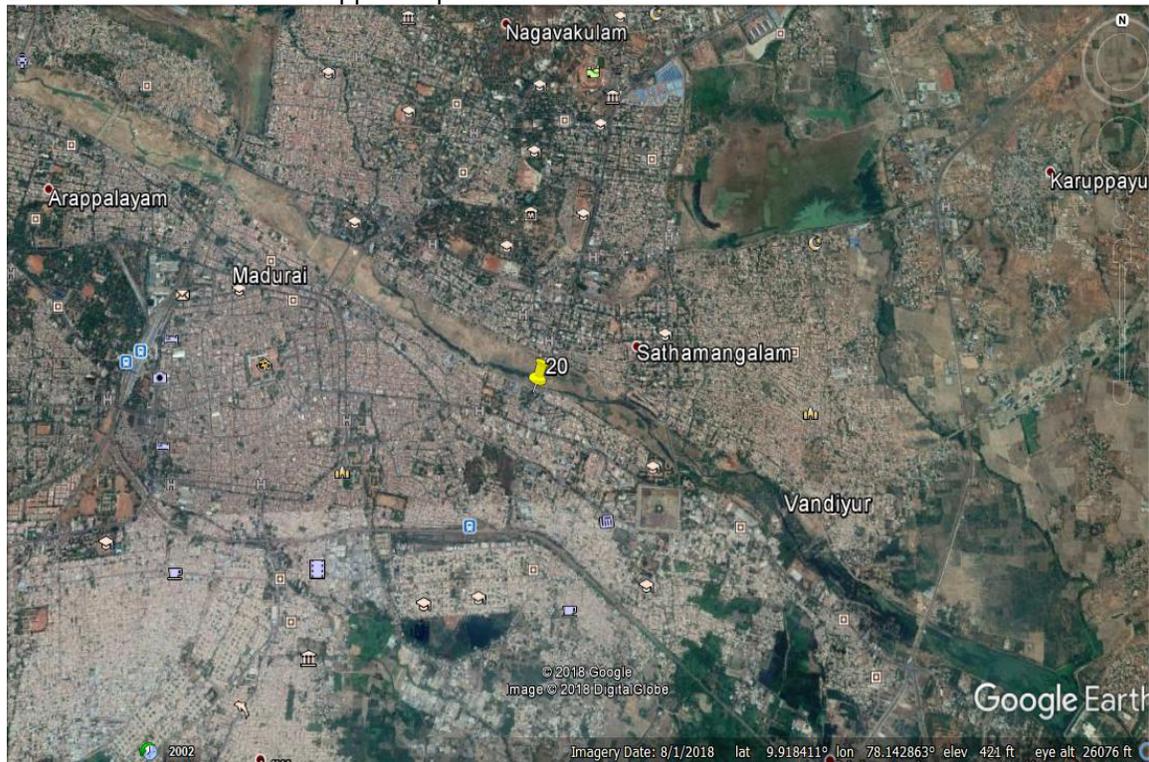
Location No: 17 - Thideer Nagar



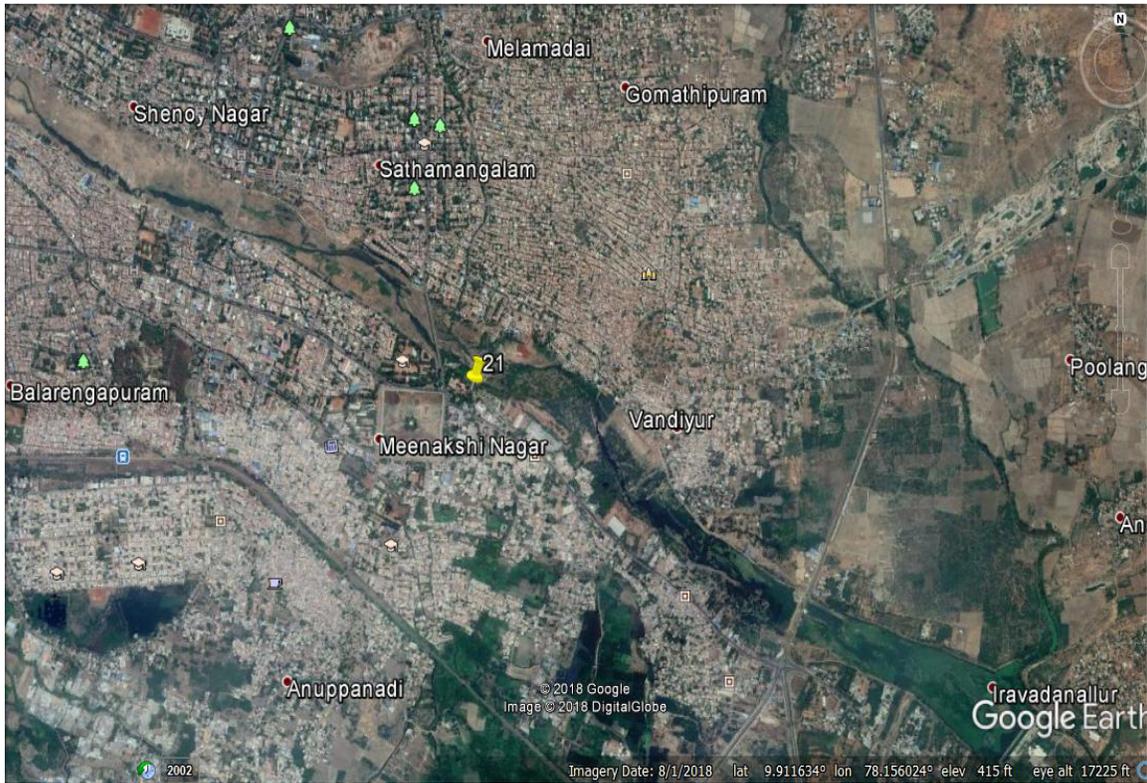
Location No: 18 - Thideer Nagar



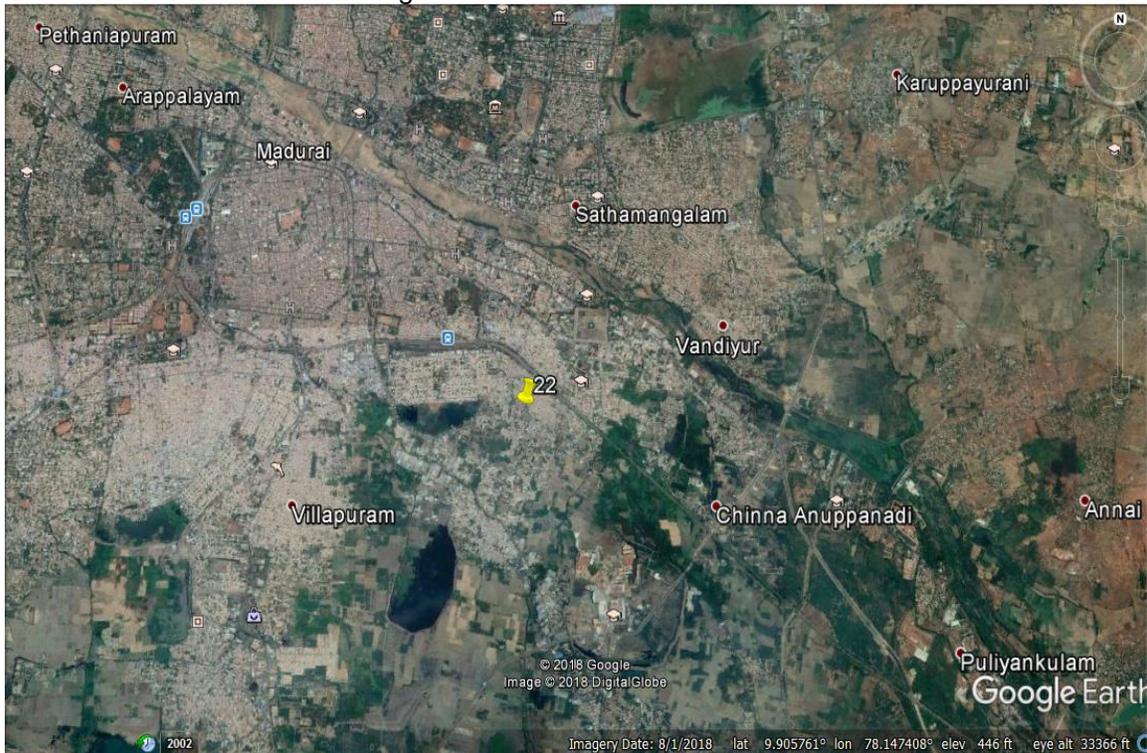
Location No: 19 - Vaalaithoppu Corporation Ground



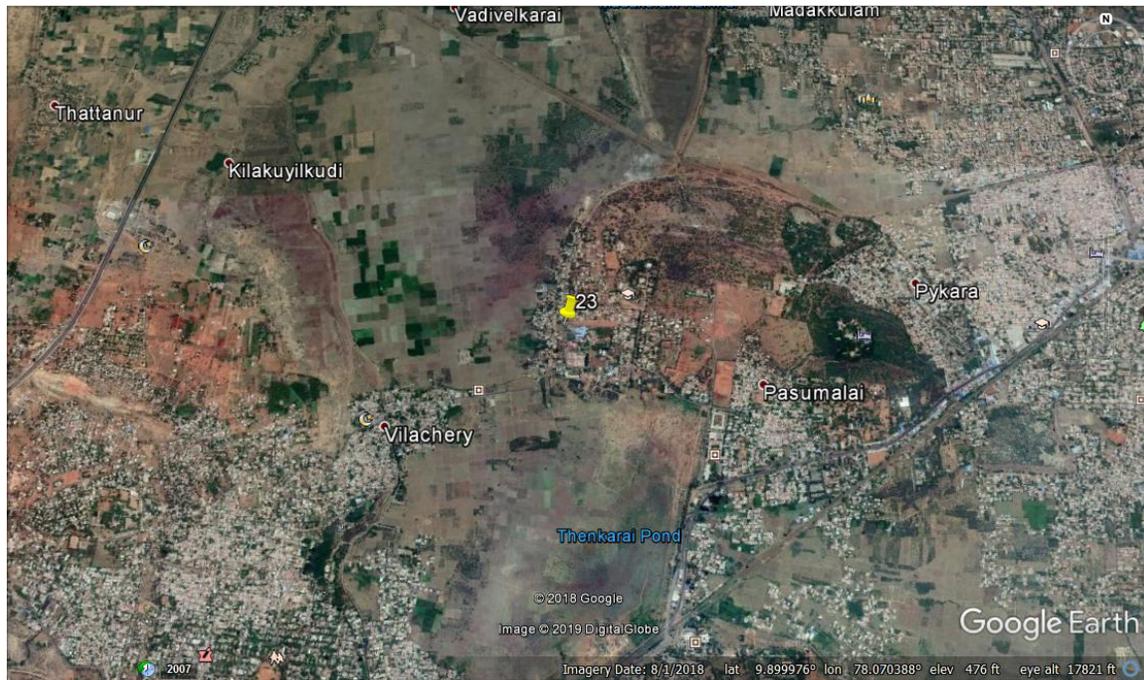
Location No: 20 - AVSS Hospital behind MPS Santhaipeitai



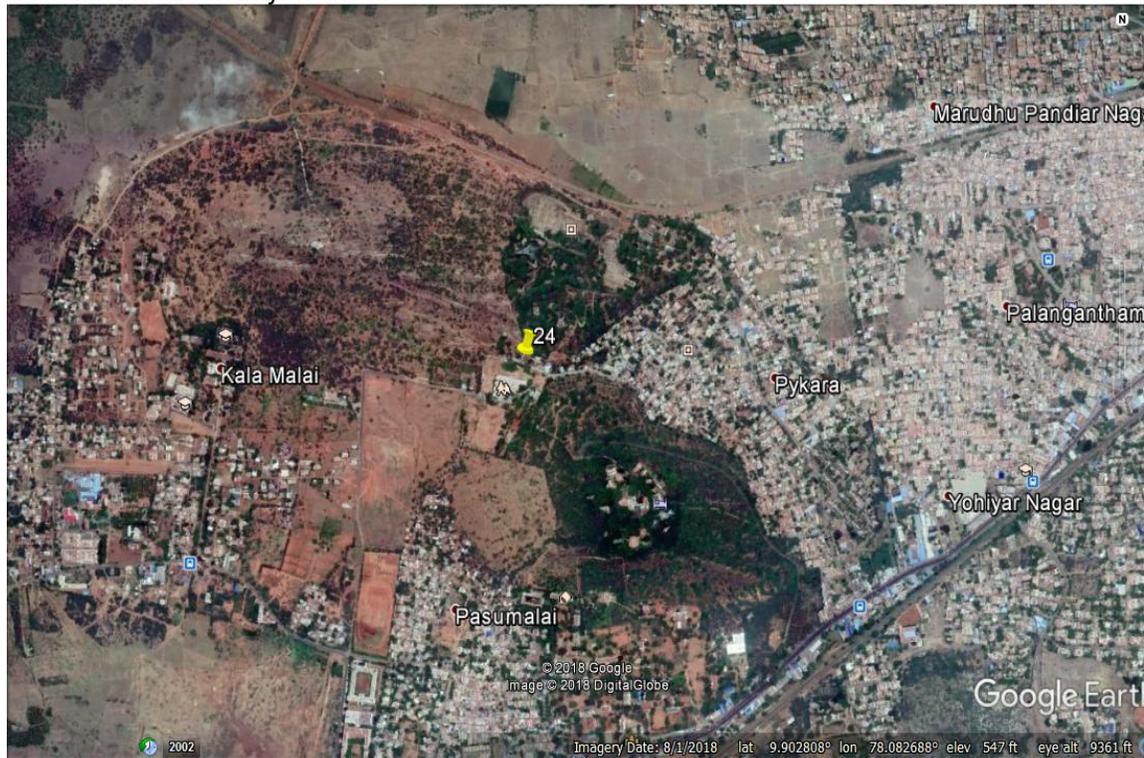
Location No: 21 - Meenakshi Nagar



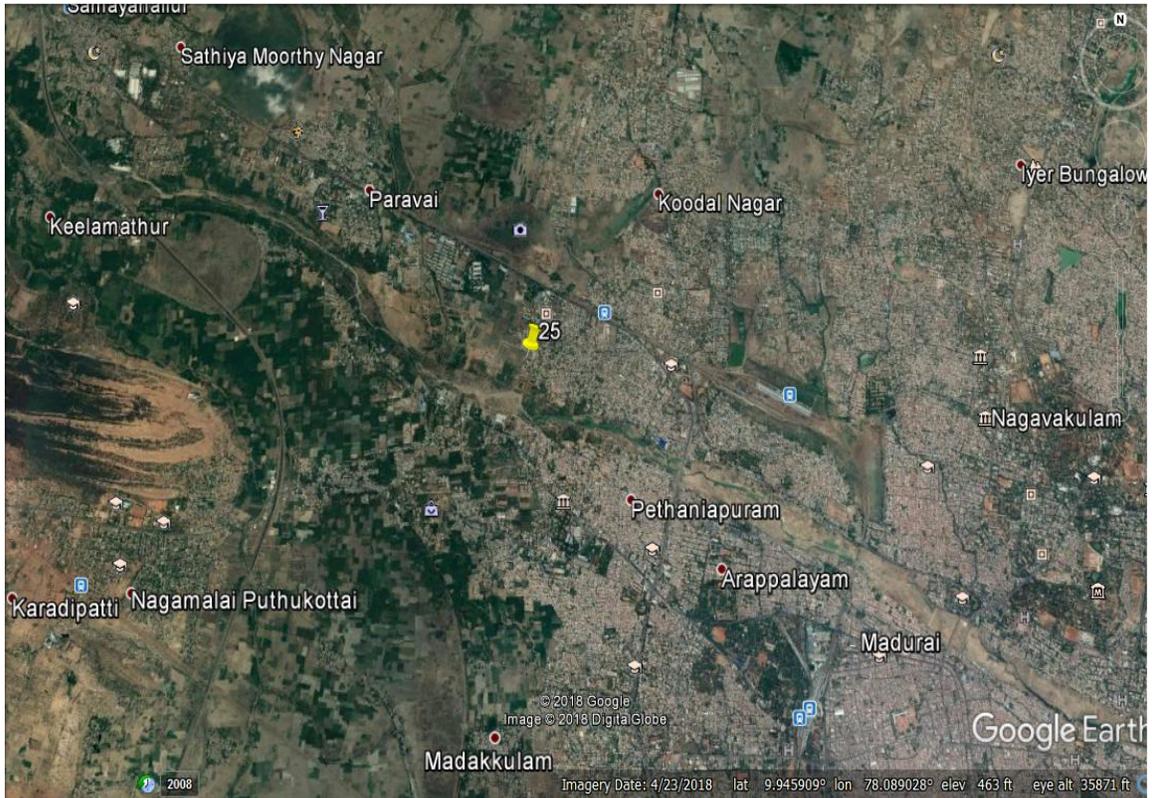
Location No: 22 - Slaughter House



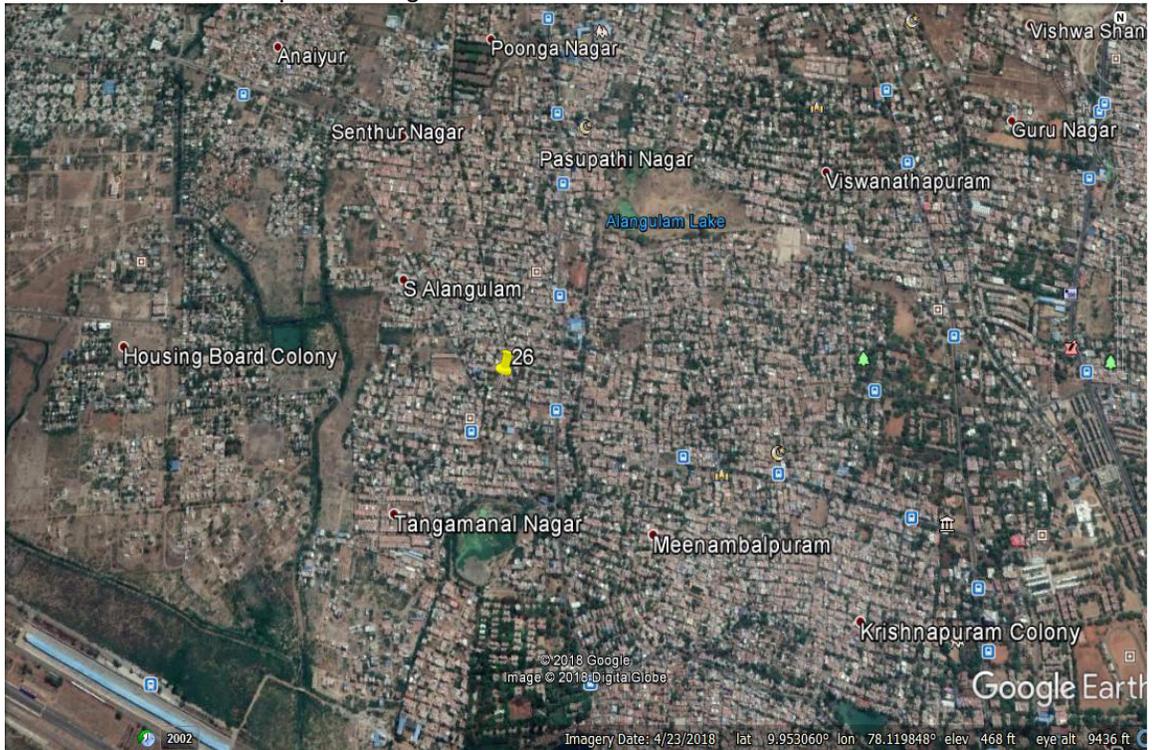
Location No: 23 Muniyandikovil



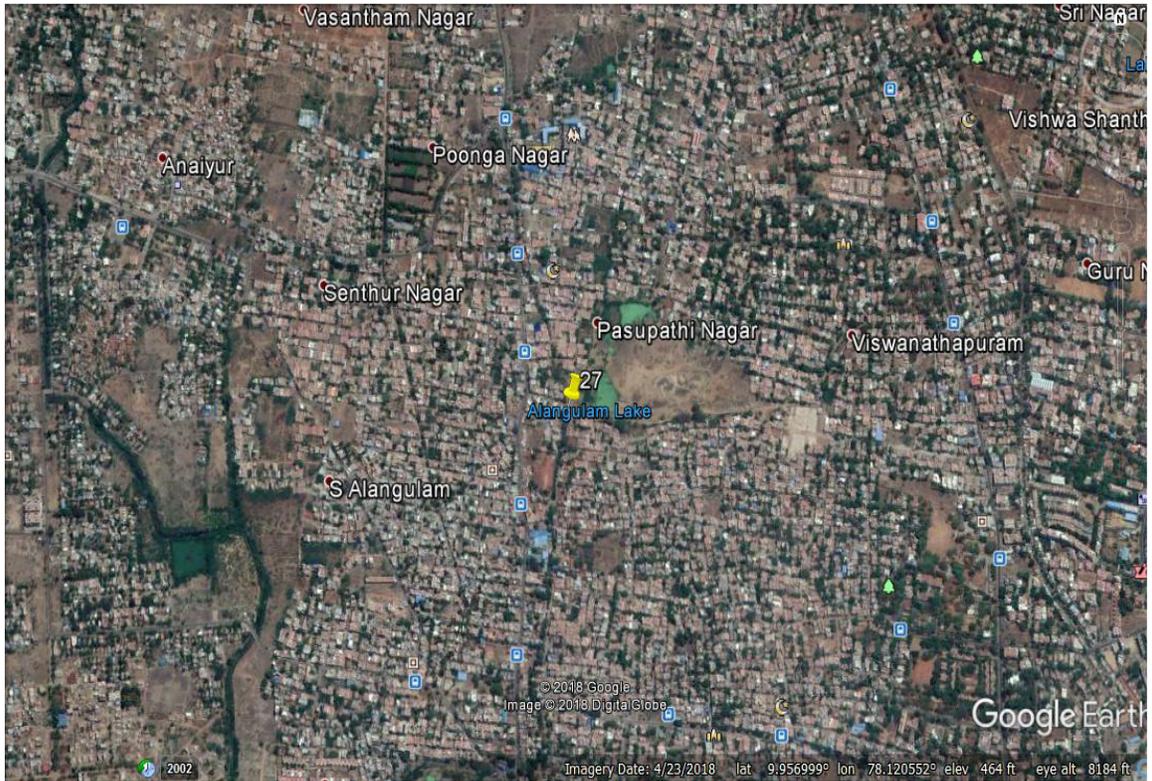
Location No: 24 - Muthuramalinga Puram, Bykara



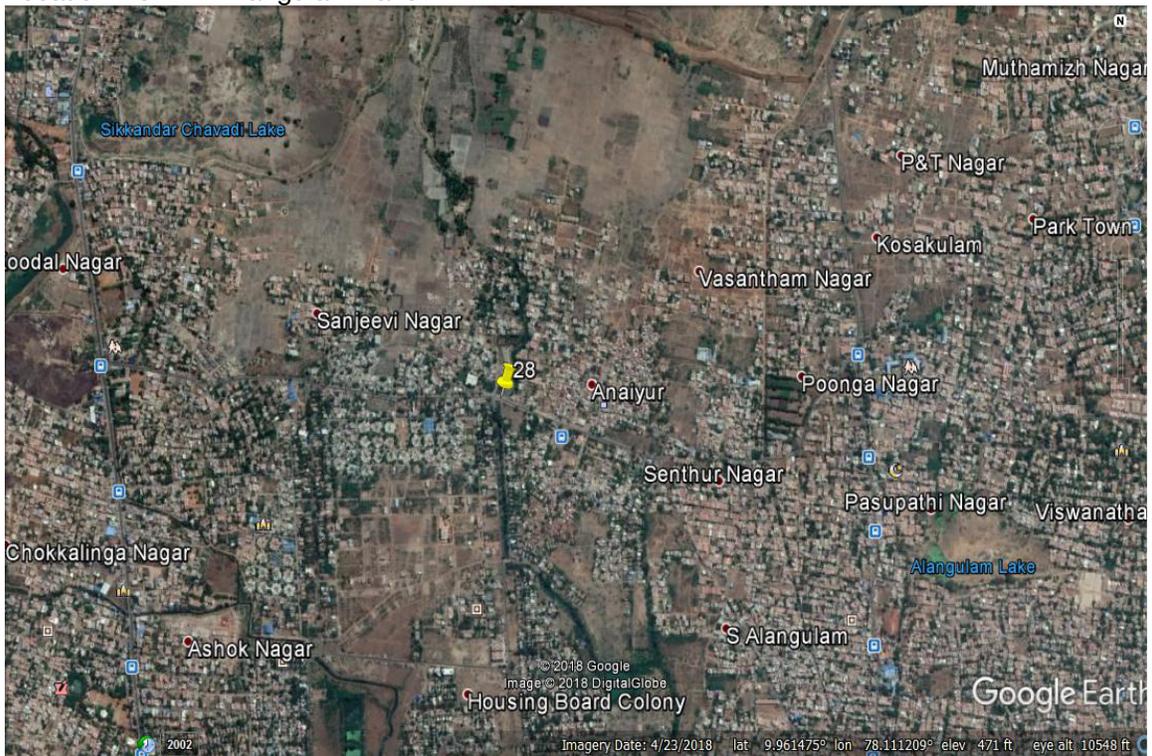
Location No: 25 - Semparuthi Nagar – NZ1



Location No: 26 - Mudakkathan –N24



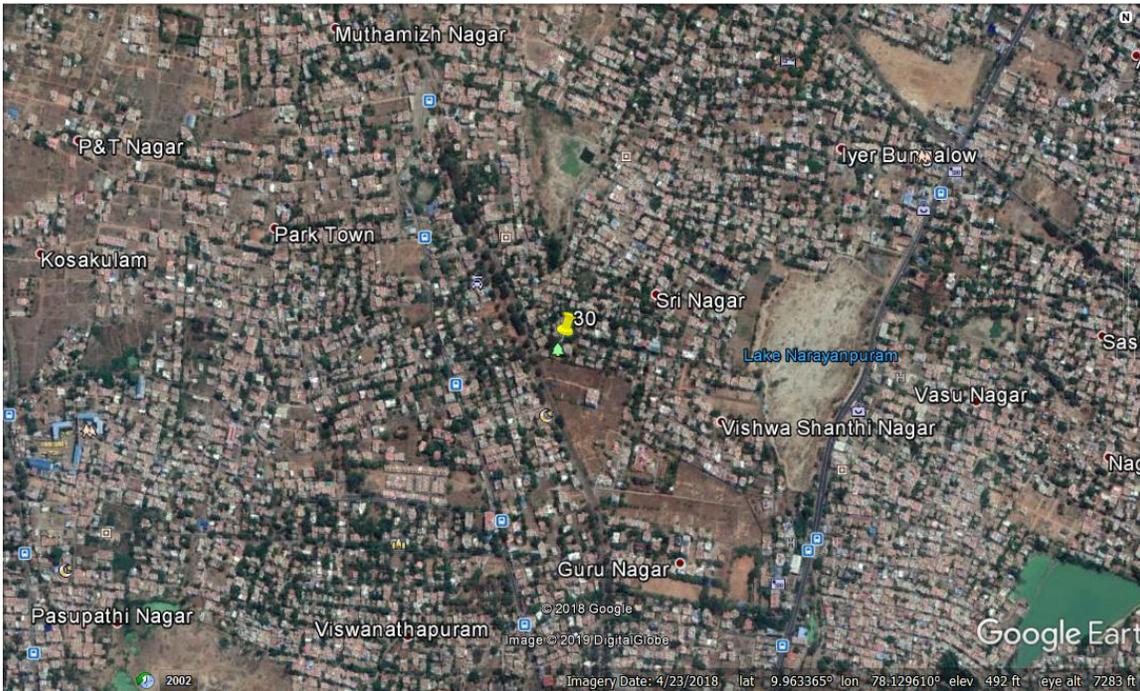
Location No: 27 - Alangulam Lake –N24A



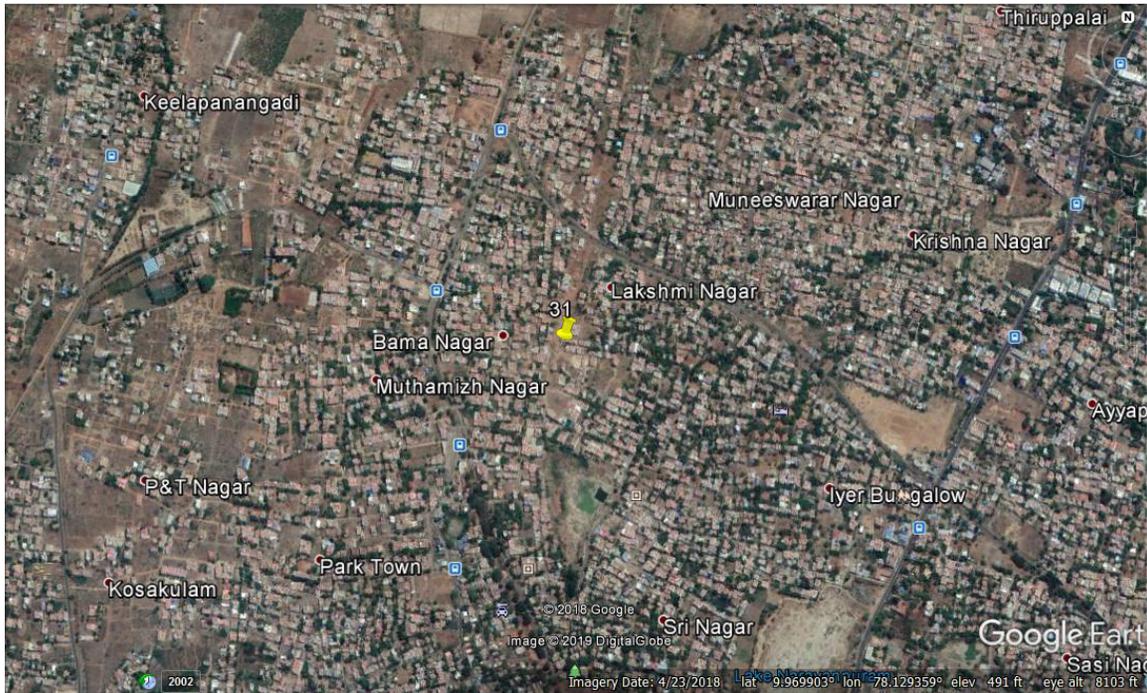
Location No: 28 - Anaiyur – NZ3



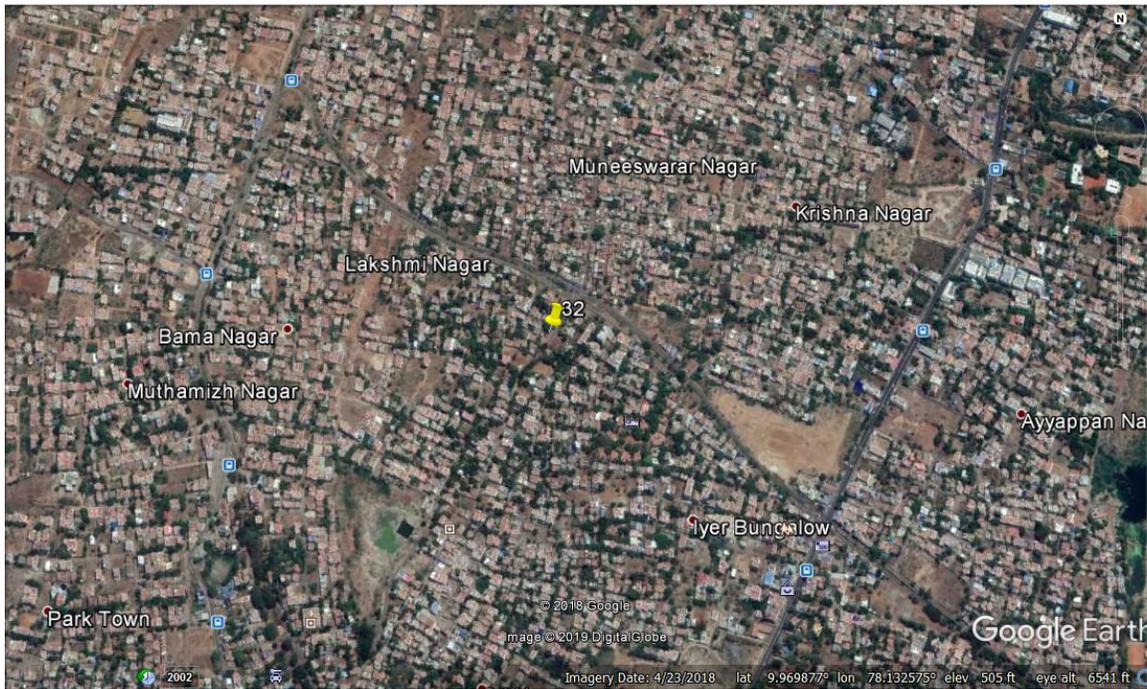
Location No:29 - Indranagar – NZ2



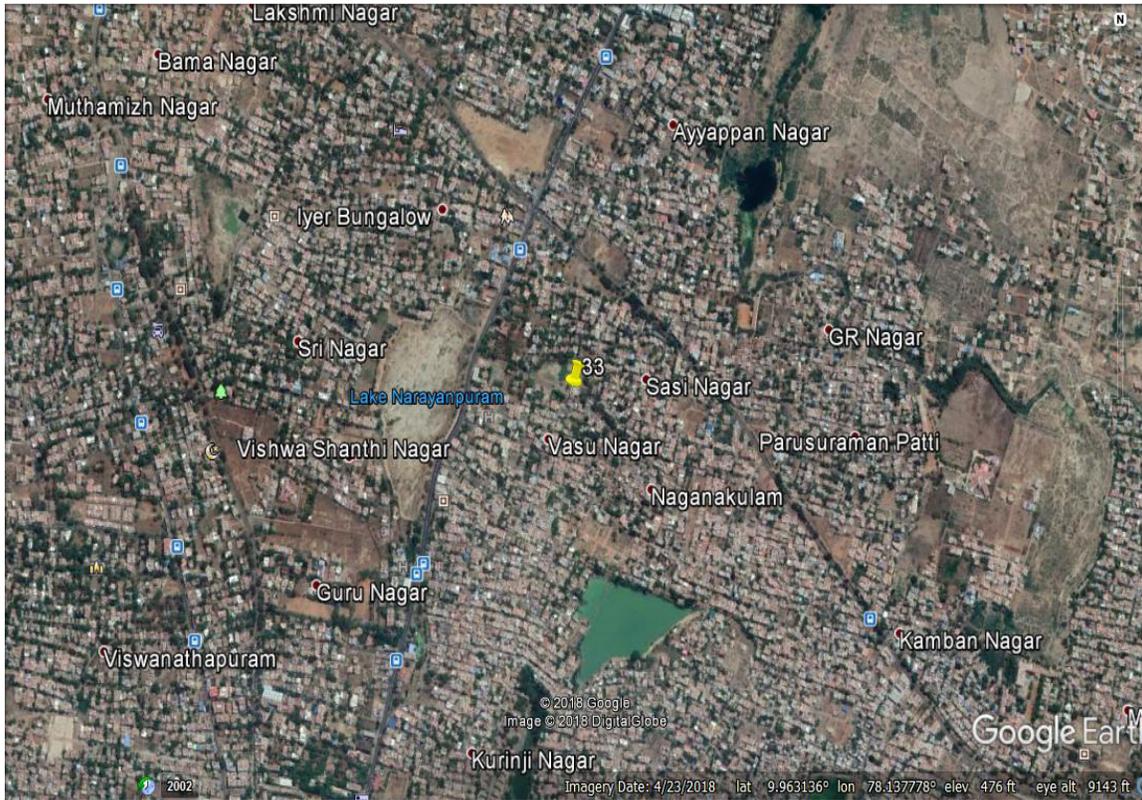
Location No: 30 - Park town - Park Town – NZ5



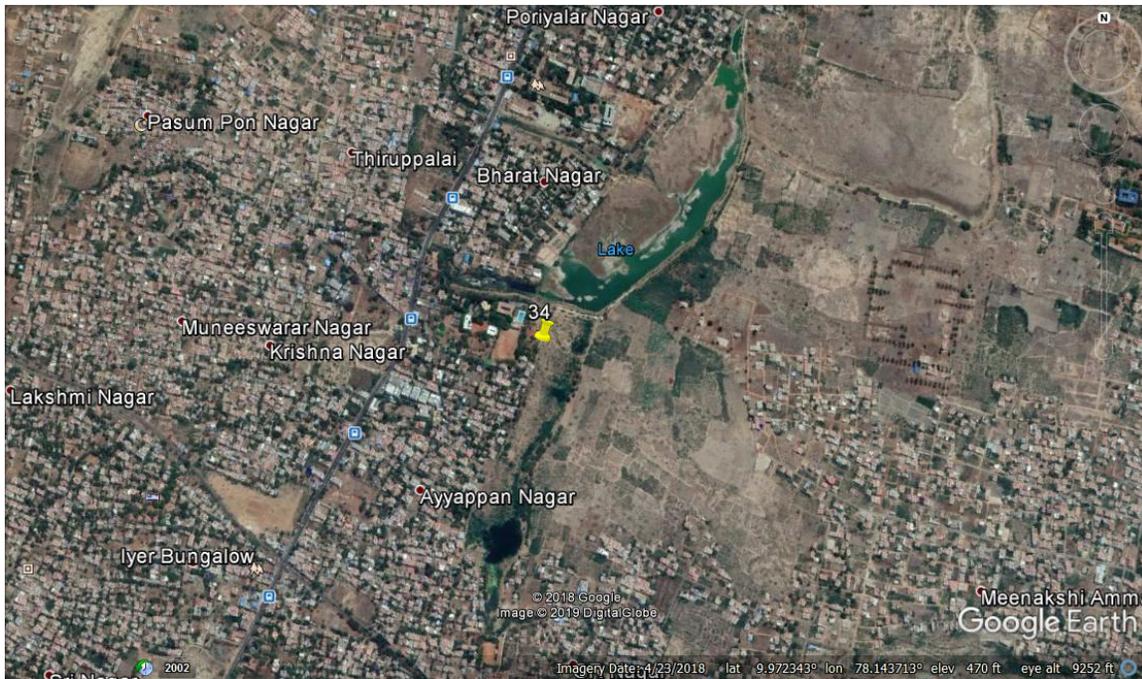
Location No: 31 - Thiruppalai (Chakra Nagar)



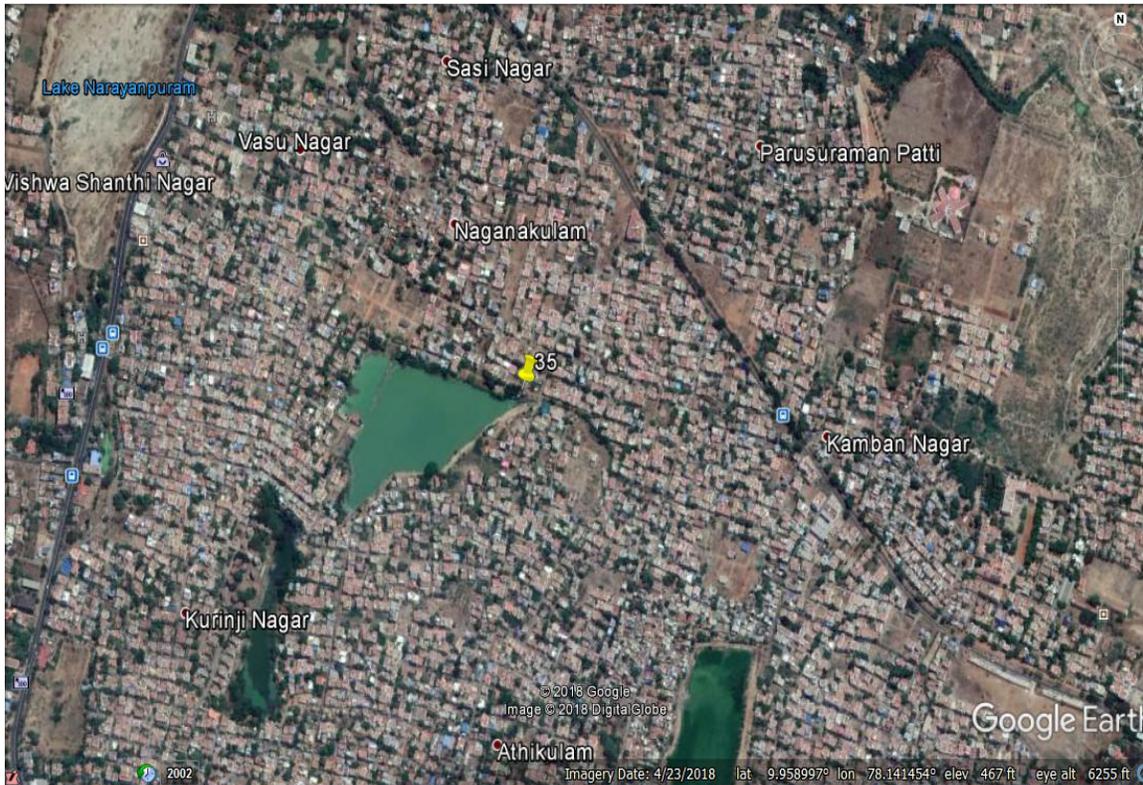
Location No: 32 - EB colony



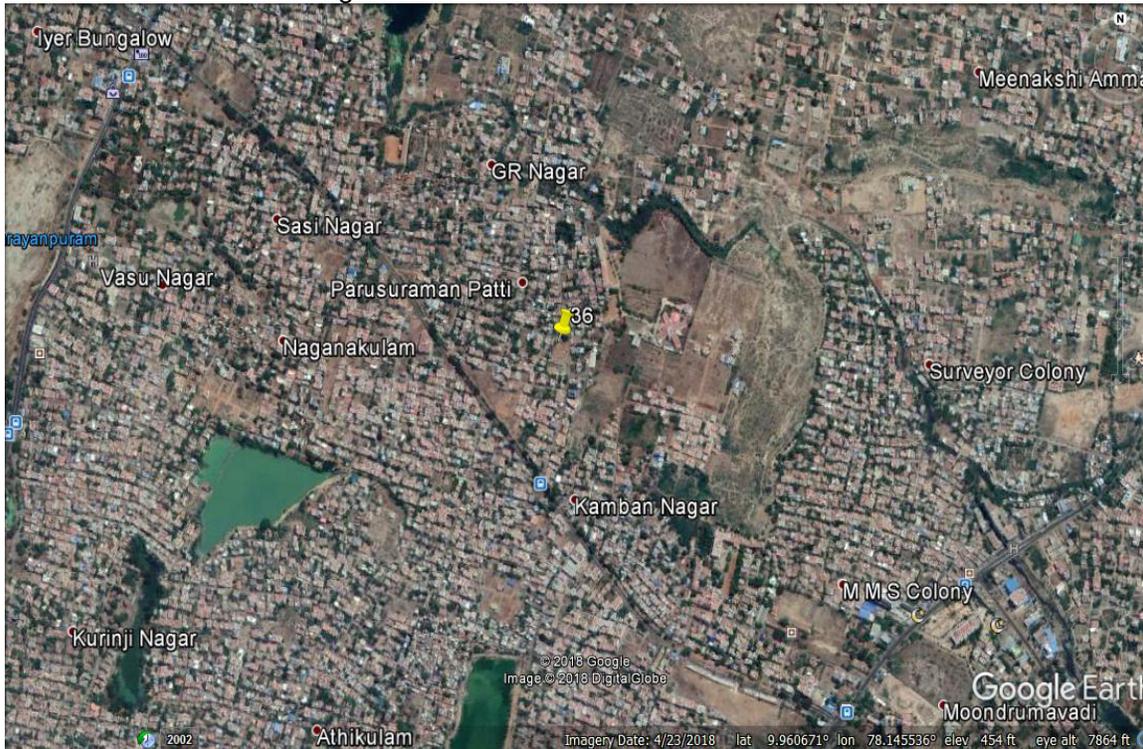
Location No: 33 - Naganakulam



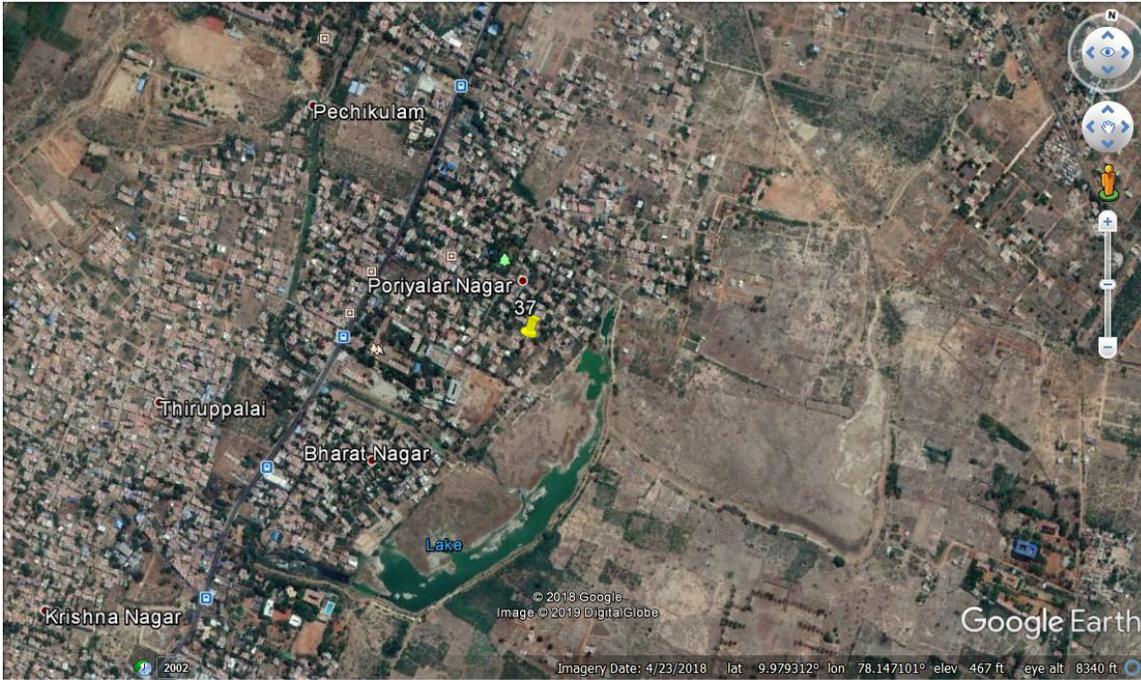
Location No: 34 - Bharath Nagar



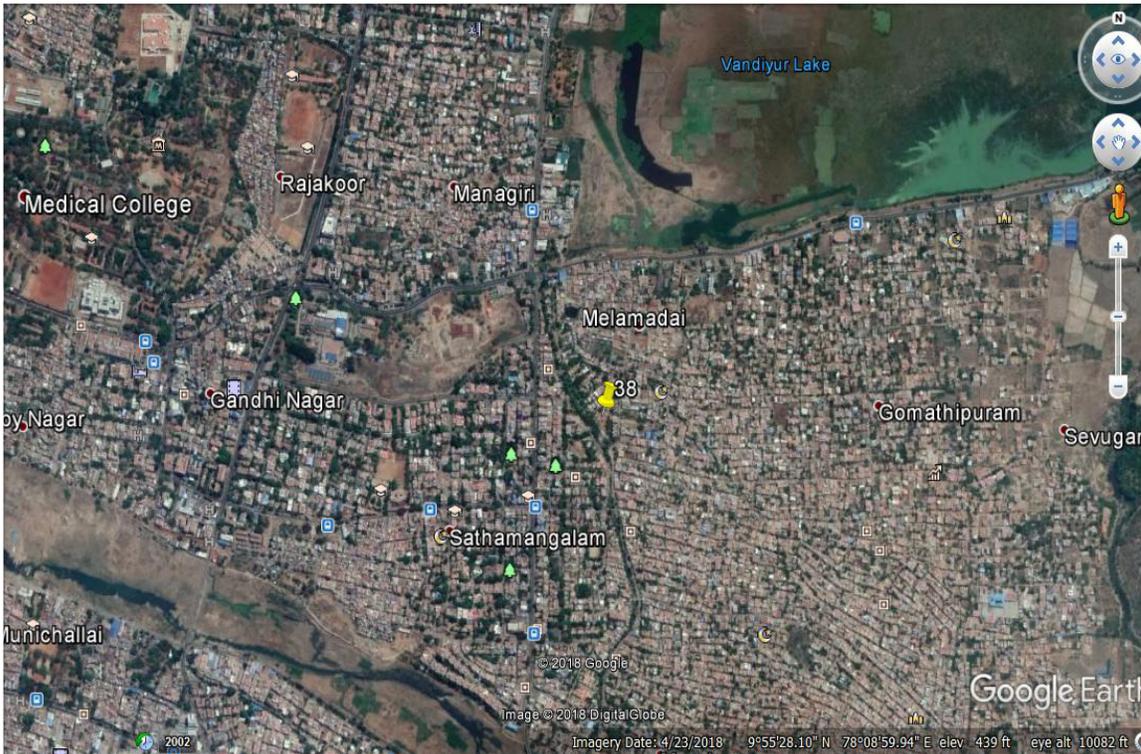
Location No: 35 - Island Nagar – NZ8



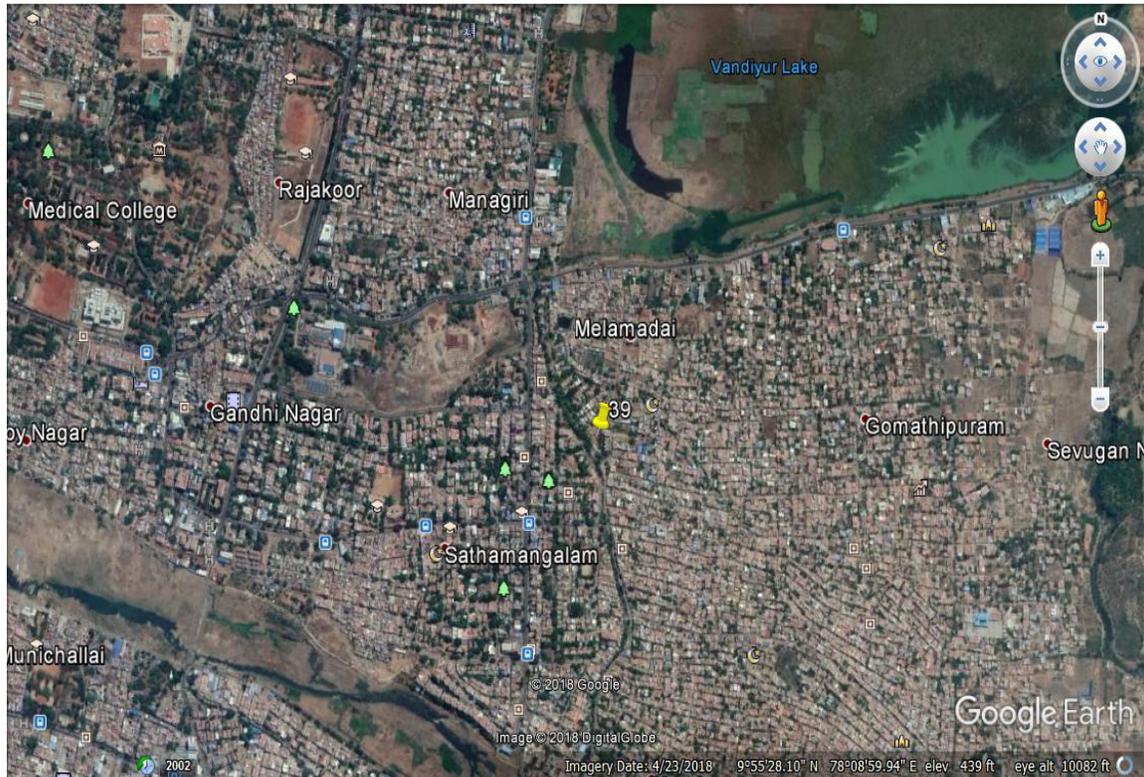
Location No: 36 - GR Nagar – NZ9



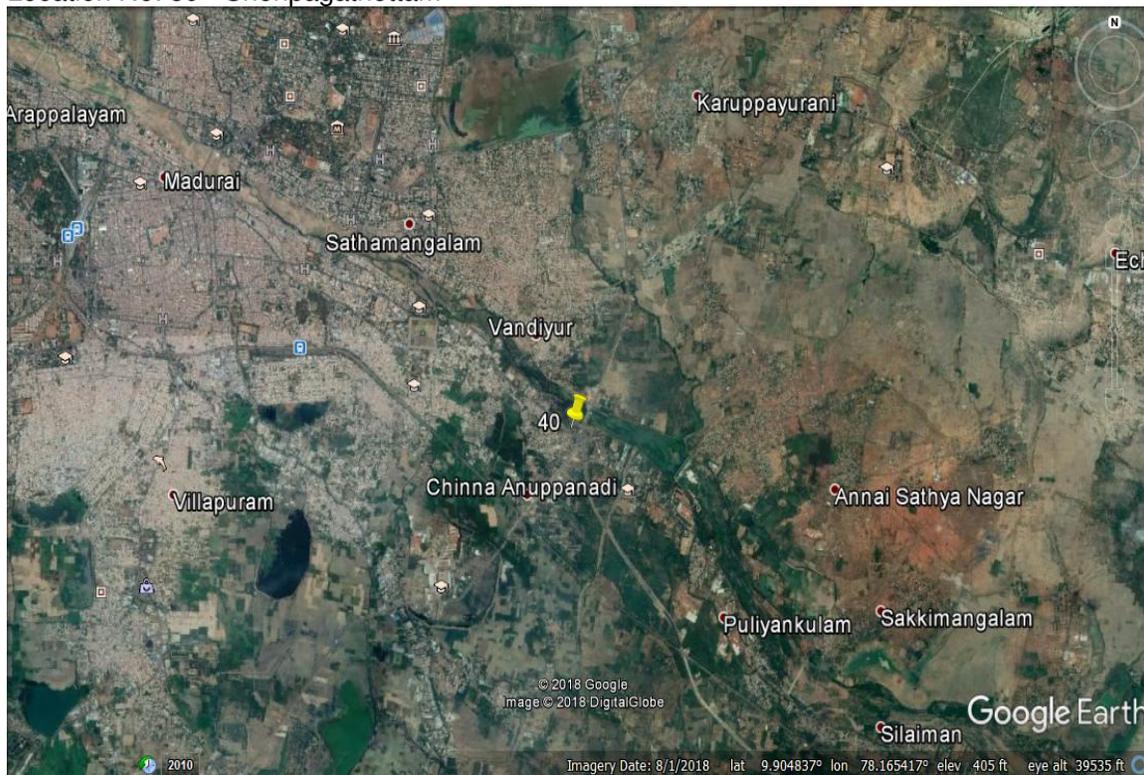
Location No: 37 – Poriyalar Nagar



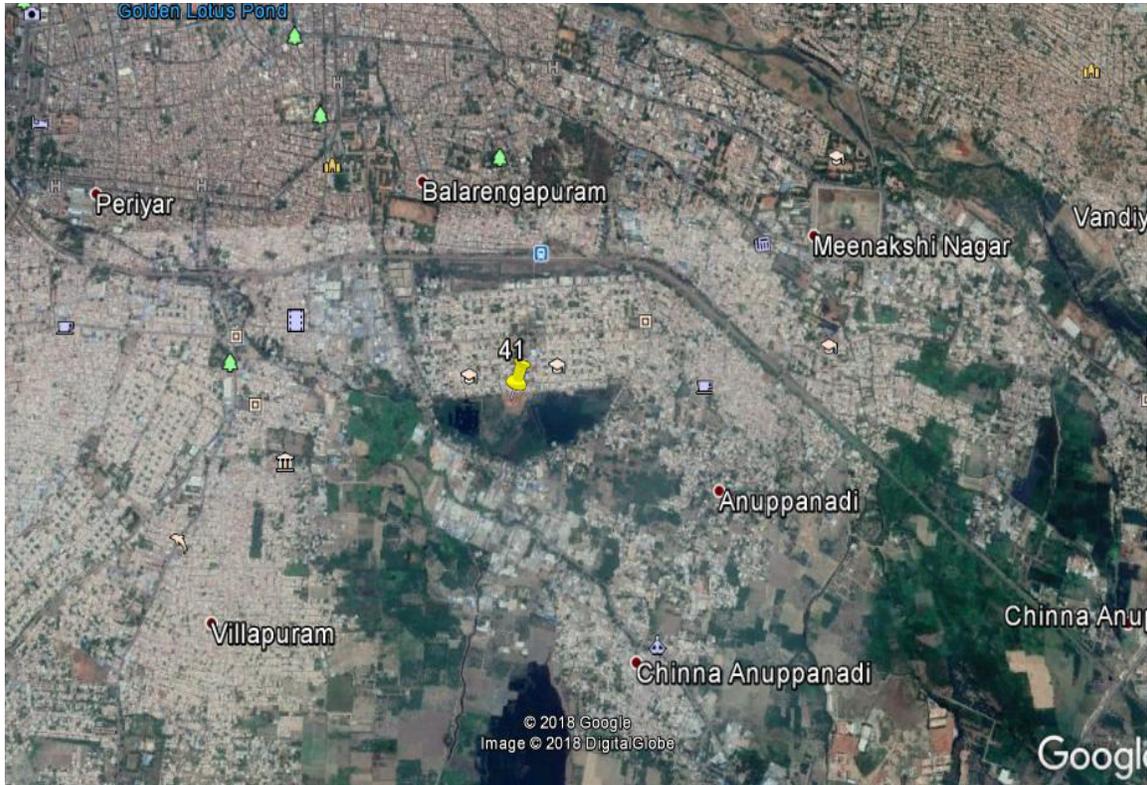
Location No: 38 - Shenpagathottam



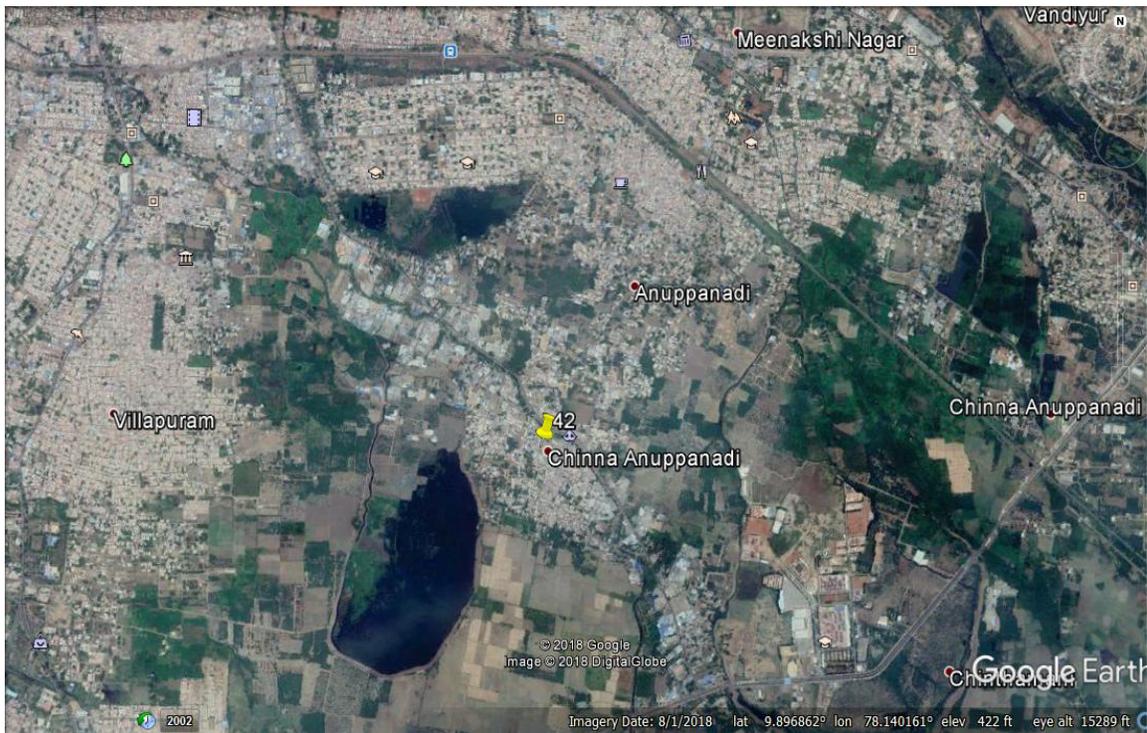
Location No: 39 - Shenpagathottam



Location No: 40 - Iravathanallur – SZ1



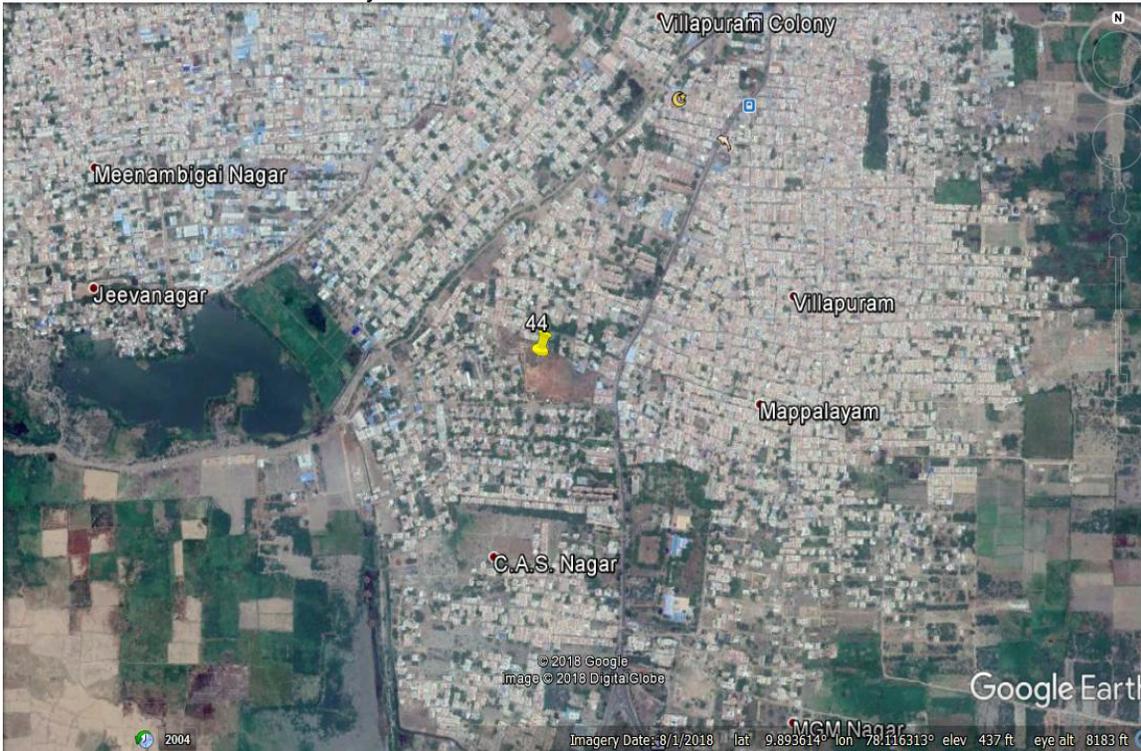
Location No: 41 - Chinna Anuppanadi –SZ2



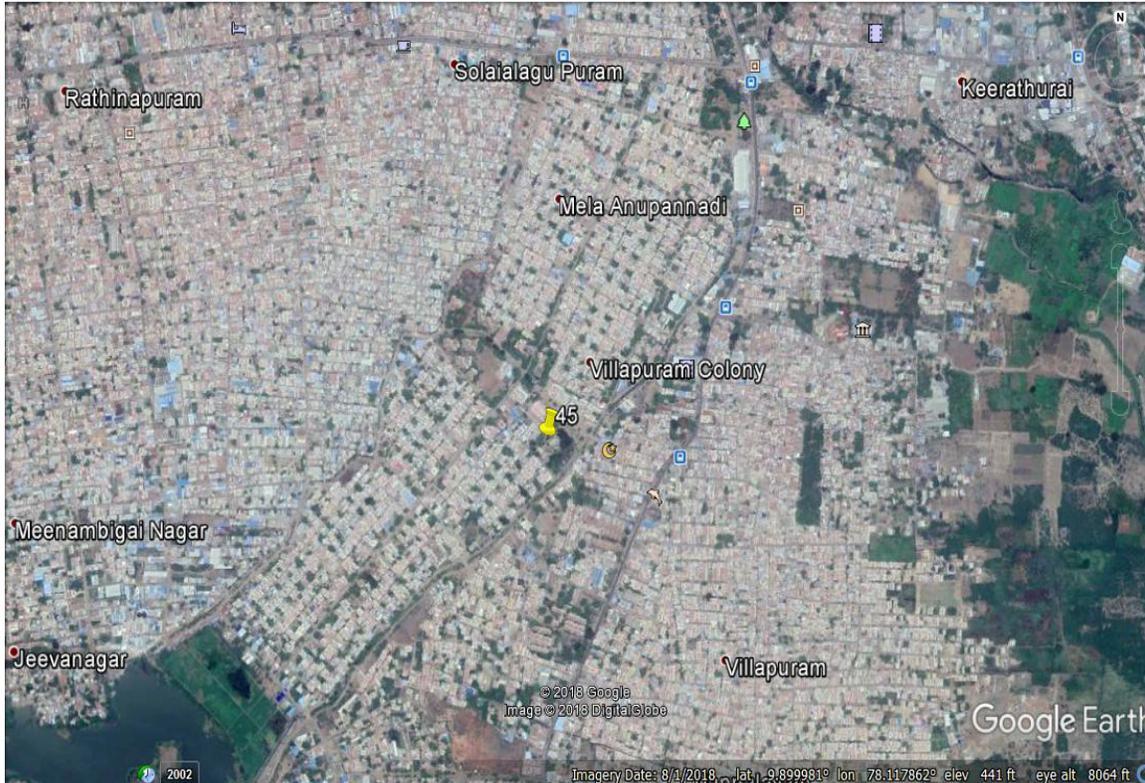
Location No: 42 - Gurunathar Koil – SZ3 (Chinntamani)



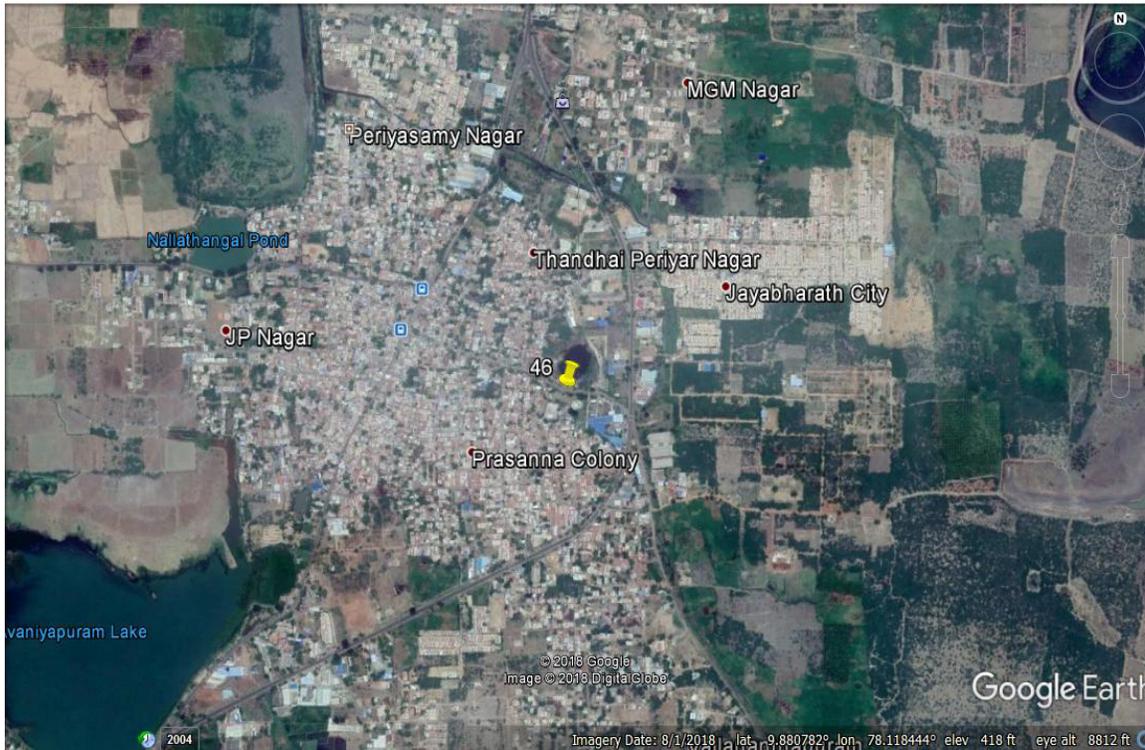
Location No: 43 - MMC Colony –SZ 5



Location No: 44 - MMC Colony –SZ4



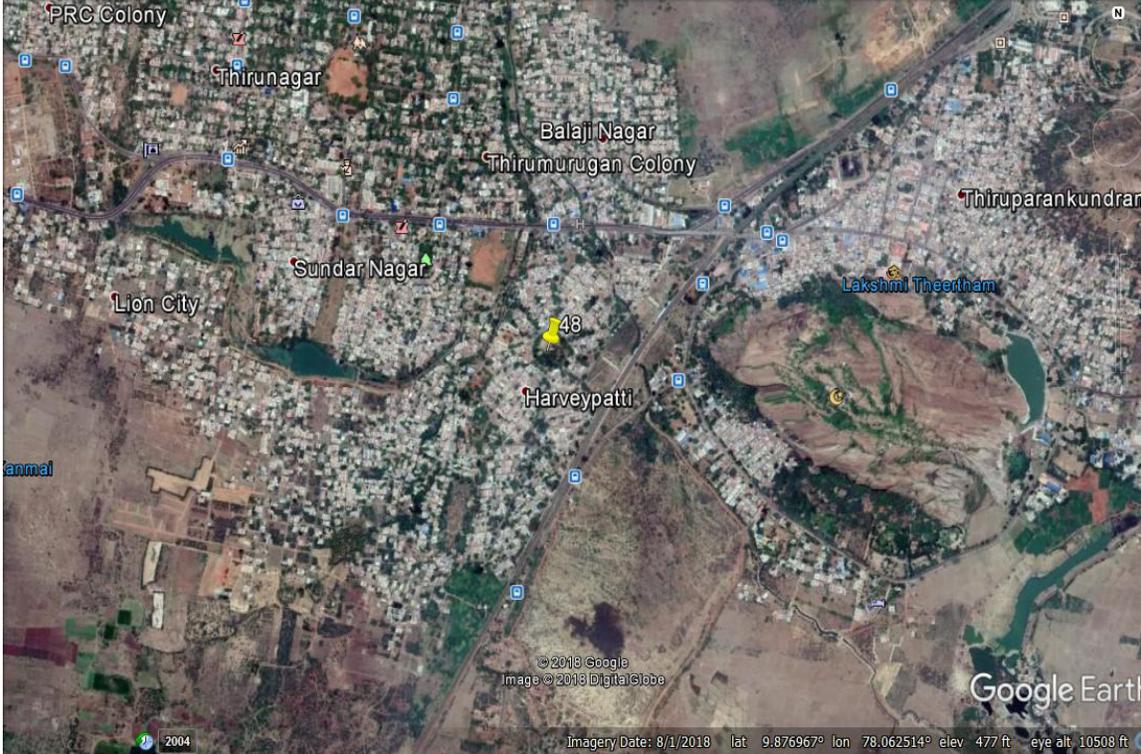
Location No: 45 - Villapuram – SZ6 (Ward – 61)



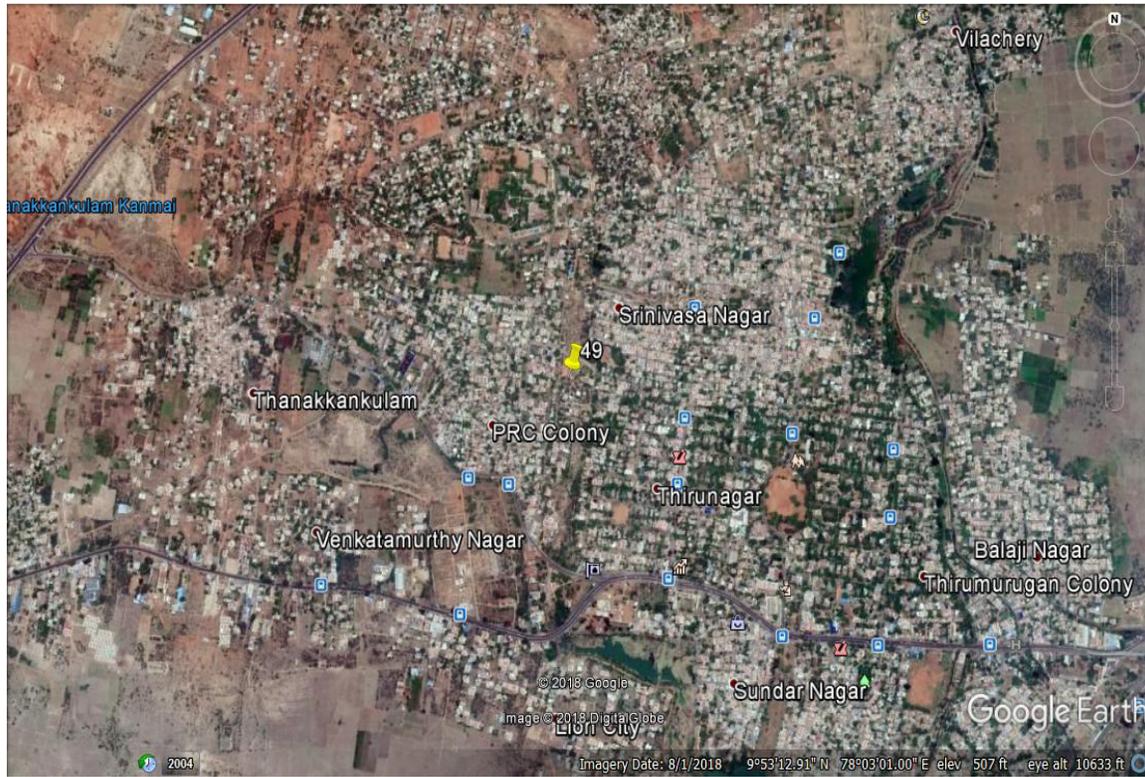
Location No: 46 - Sempoorani – SZ7



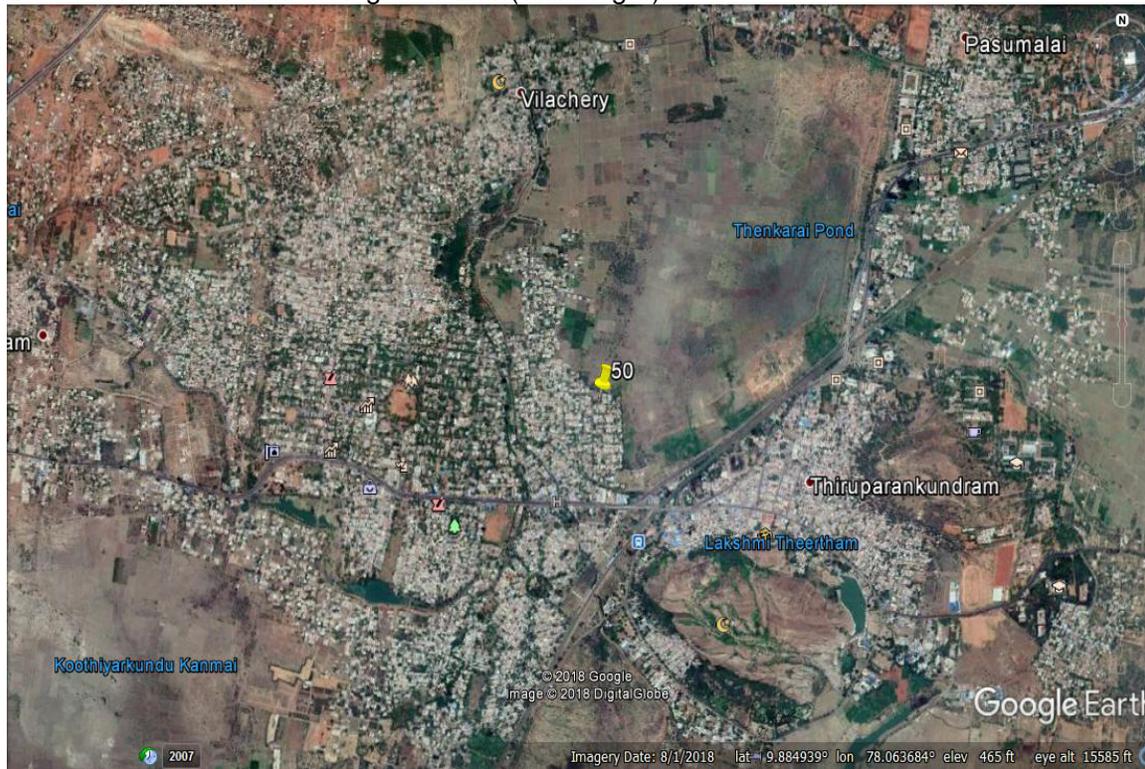
Location No: 47 - Velakkal



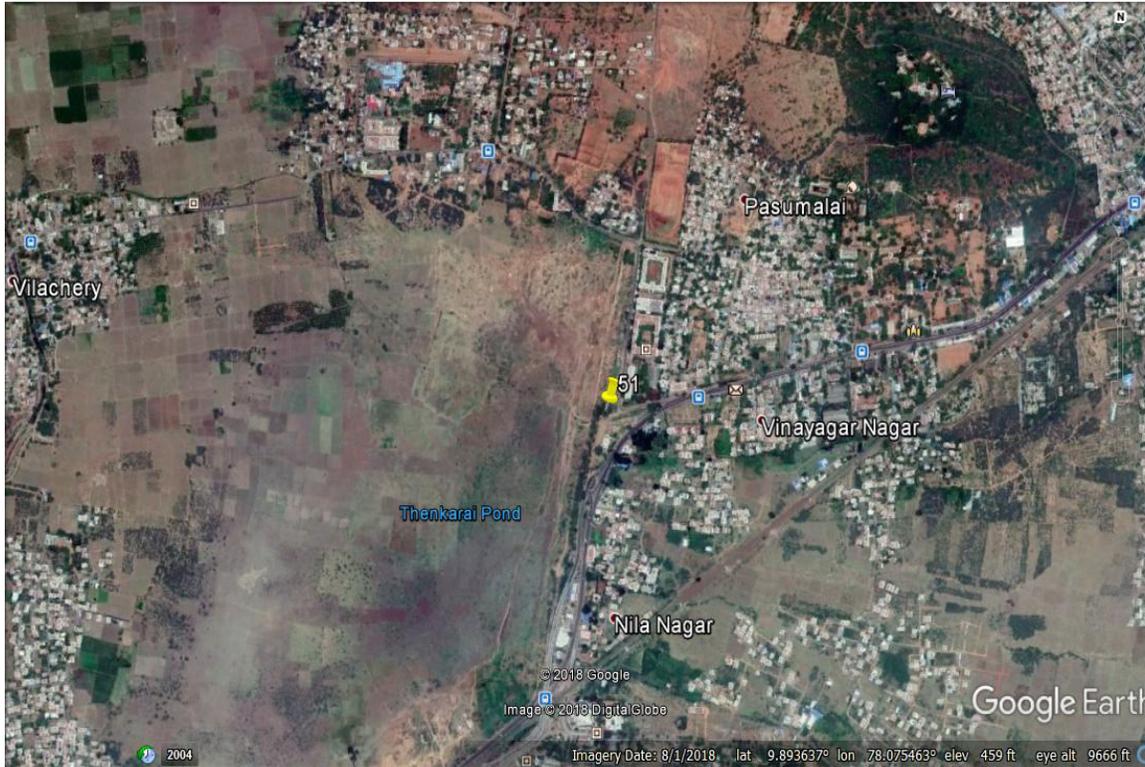
Location No: 48 - Harveypatti – SZ10



Location No: 49 - Kurinchi Nagar – SZ11 (Thirunagar)



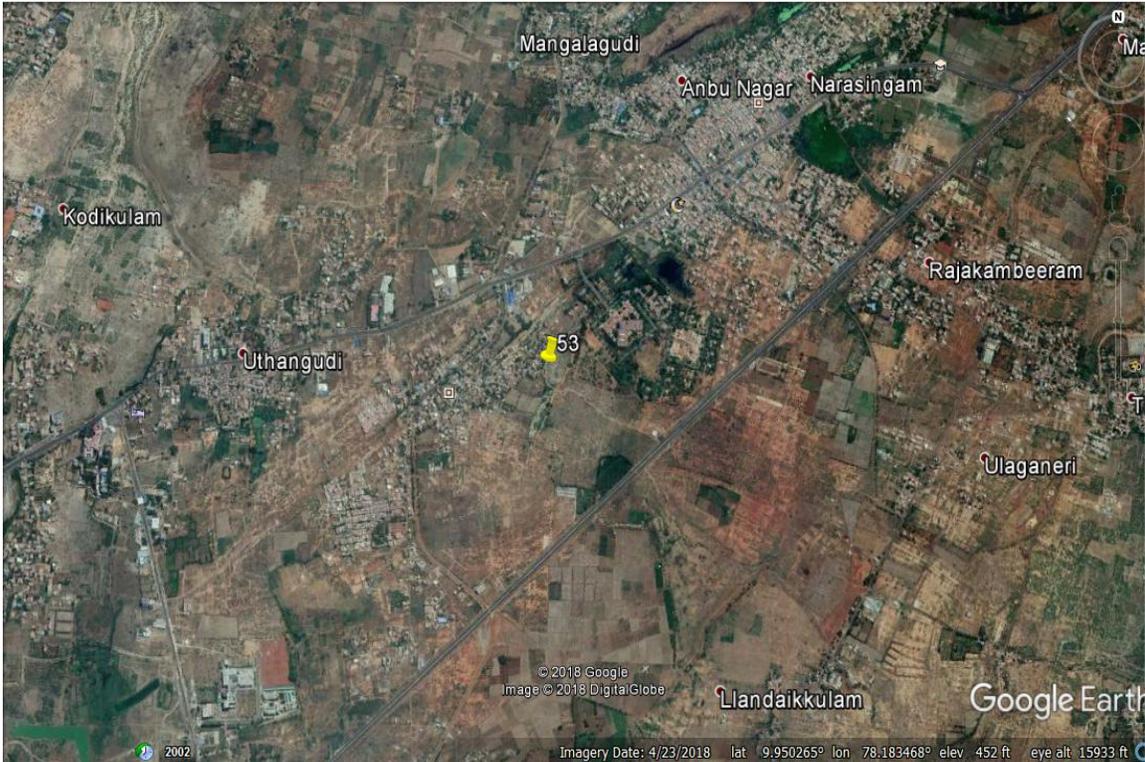
Location No: 50 - Balaji Nagar – SZ12



Location No: 51 - Moolakarai Sump – SZ9



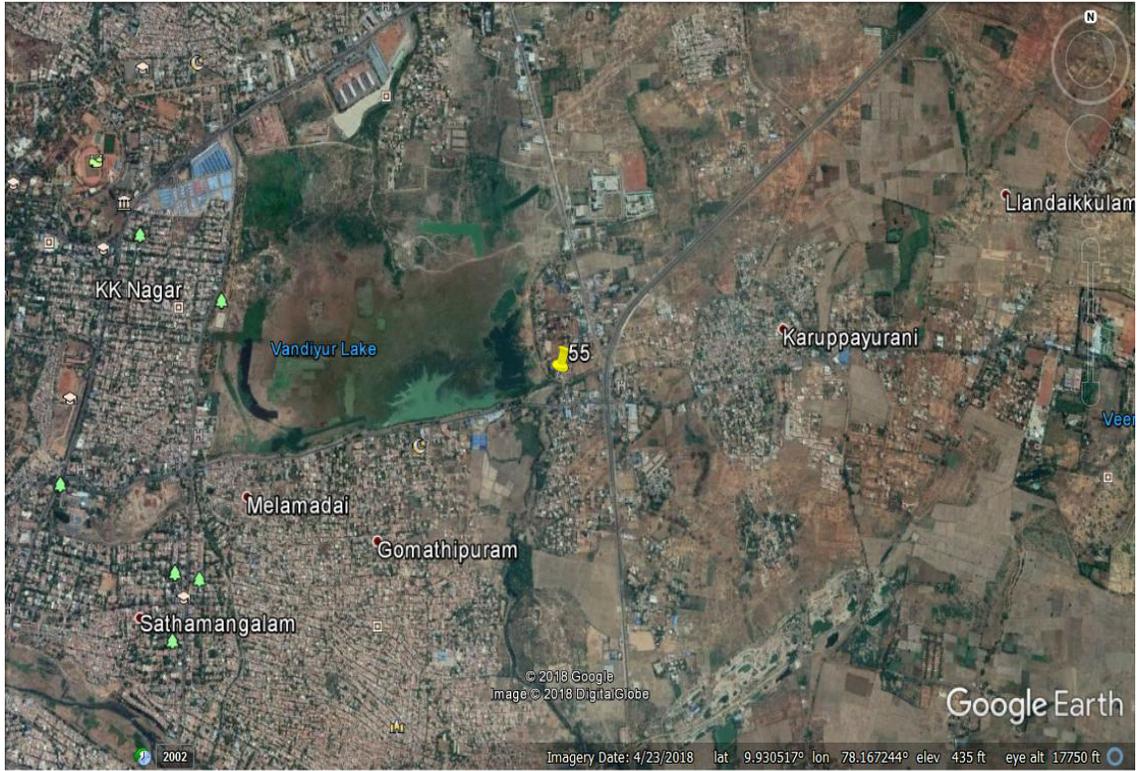
Location No: 52 - Pasumalai – SZ13



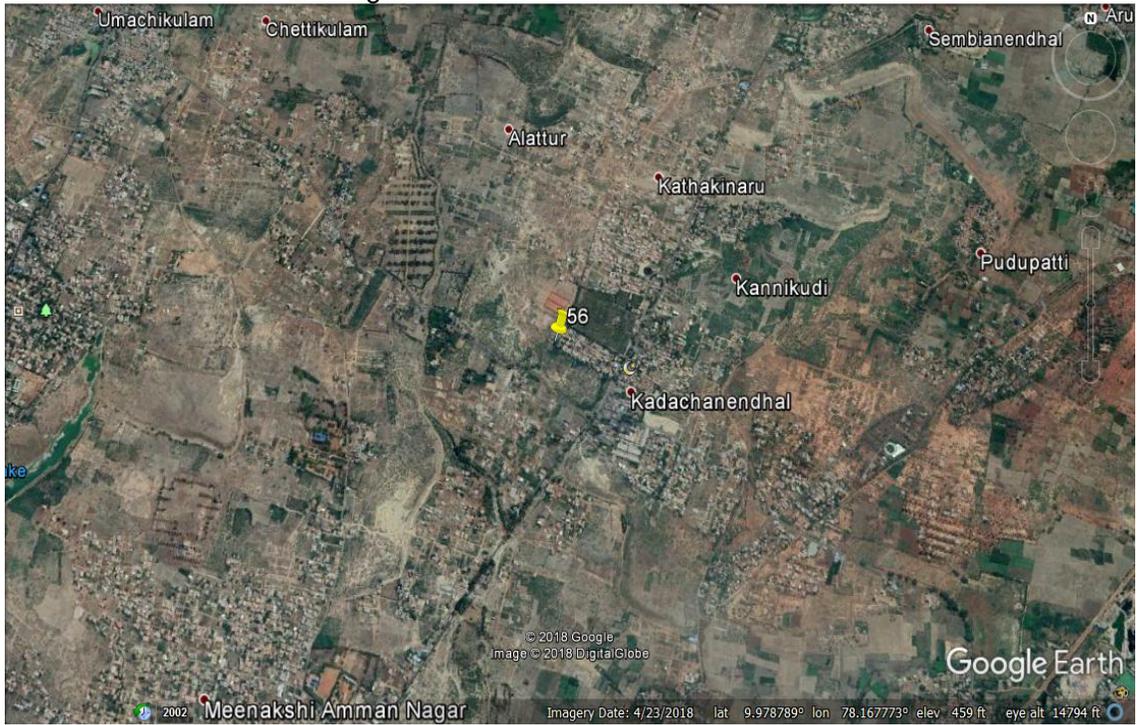
Location No: 53 - Ulaganeri – NZ 11 (Ward – 28)



Location No: 54 - Pandian Nagar – NZ12



Location No: 55 - Pandian Nagar – NZ13



Location No: 56 - Kadachanendhal - Ward 26

Appendix 16: Public Consultation at OHT locations

A total of 56 OHT locations has been identified for water distribution under the “**Dedicated Water Supply Scheme for Madurai Corporation from MullaiPeriyar at Lower camp**”. Out of 56 OHT’s, 24 OHT locations were identified for conducting public consultations, which was held from 13th February 2019 to 15th February 2019. The locations were selected based on the presence of socially important locations including the public park area, playground, burial ground, temples etc., consultation was held. The outcome of the consultation has been discussed in the following tables.

I. Minutes of meeting for “Dedicated Water Supply Scheme for Madurai Corporation from MullaiPeriyar at Lower Camp” held on 13.02.2019

| S.No | Participants | Outcome of the Consultation and Discussions | Response from PIU | Photographs |
|------|--|---|--|---|
| 1. | <p>OHT # 14 and 15 OHT Location: TVS Park Sathyasai Nagar</p> <p>M. Maheshwari, K. Marreswari, M. Barani, M. Sweety, R. Ghanam, K. Selvarajan, L. Alagiriraj, P.S. Pandiyan, S.G. Palsamy, K. Alagarsamy, T.K.S. Omana,</p> <p>N.V. Dhayarathi – HM (TVS - HSS) P. Jeyanthi – HM (TVS - HSS)</p> | <p>In general, the proposal has been welcomed by the local people and they have shown unanimous support for the project</p> <ul style="list-style-type: none"> • There is no objection for the construction of the OHT in the Public Park. • What would be the project completion date? | <p>It was informed by the PIU, that the work shall be completed within two years from the date of contract</p> |  |

| S.No | Participants | Outcome of the Consultation and Discussions | Response from PIU | Photographs |
|------|---|---|--|--|
| 2. | <p>OHT# 47 OHT location:Vellakal Rasuthevar, Pandi, M. Karunanithi, P. Arunachalam, T. Rajkumar, P. Prabhu, S. Renugadevi, J. Pasumpon, R. Jeyanthimala, P. Malliga, A. Meenakshi, Murugayi, Chitra Ponnammal, Petchi, Pandiyammal, Reyalakshmi, T. Shanmuganathan</p> | <p>It was informed that the area is facing irregular water supply and hence it was requested to construct the OHT at the earliest so as to get regular water</p> | <p>It was assured by the PIU to construct the OHT at the earliest so as to facilitate the regular water supply</p> |  |
| 3. | <p>OHT# 48 OHT location:Harvipatti S. Mariappan, G. Elankumaran, M. Ayyavu, K. Murugan, S. Ramalakshmi, K. Muthu, K. Amutha, P. Ellappan, Ganguly, G. Ramakrishnan, A. Jayabalan, M. Sangaiya, L. Raja murugan, P. Saravanapandi, S. Babu, G. Magudapathy, S. Pathiban (VIII A), G. Chandran (VIII A), R. Ramar, R. Lakshmanan, S. Dharun, K. Manikandan, S. Sanjay Kumar, S. Vetrivelan, R. Harivignesh, R.P. JeevaRagavan</p> | <p>It was informed that due to irregular water supply, there is scarcity of water for drinking purposes and hence the local people have requested to construct the OHT at the earliest. However, it was suggested to shift the location of the OHT near to an existing one, so as to provide space for the children's to use it as a play area.</p> <p>It was requested to have proper barricading/ fence to prevent children's entering the OHT area.</p> <p>It was suggested not to have borewell in the area</p> | <p>The PIU have accepted the request and assured that the new OHT shall be constructed near the existing one and it will be properly barricaded to prevent the children's entering the site.</p> <p>It was assured that there borewell will not be constructed in the OHT area</p> |  |

| S.No | Participants | Outcome of the Consultation and Discussions | Response from PIU | Photographs |
|------|--|---|--|---|
| 4. | OHT# 50 OHT location:Balaji Nagar A.A. Sethuram, P. Rajendran, V. Ganapathi, N. Shanmugasundaram, K. Palanikumar, A.J. Abdul nazeer, R. Amuthavalli, T. Murugan, V. Ganesh, G. Janarthanan | Similar toHarvipatti area, due to irregular water supply, the regular activities are getting hampered. Hence, the local people have requested the PIU to construct the OHT at the earliest to solve the water related issues and also they have requested the PIU to shift the OHT inside the public park | The PIU have accepted the request and assured that the OHT shall be located inside the Public park |  |

Minutes of meeting for “Dedicated Water Supply Scheme for Madurai Corporation from MullaiPeriyar at Lower Camp” held on 14.02.2019

| S.No | Participants | Outcome of the Consultation and Discussions | Response from PIU | Photographs |
|------|--|--|---|--|
| 1. | OHT# 1 OHT location:Sengol Nagar (CAS Colony), Vilangudi A. Helen Rose, Uma devi, Velmani, P. Selvam, S. Jayaram, P. Selvaraj, S. Malliga, Palaniammal, Meenakshiamma, Thangapandi andT. Balakumar | The local community have welcomed the project and have requested to construct the OHT at the earliest to meet the water demand | It was assured by the PIU that the OHT construction shall be completed within 24 months from the date of award of contract. |  |

| S.No | Participants | Outcome of the Consultation and Discussions | Response from PIU | Photographs |
|------|--|---|---|---|
| 2. | <p>OHT# 9 OHT location:Surveyor Colony (Near Mahatma School) Anandaraj Nagar M. Rajeswari, Chinnaponnu, SM. Subramaniam, S. Deivanai, J. Vasanbabu, S. Yogesh, V. Babu and Alagurathinam</p> | <p>The local community have welcomed the project and have requested to construct the OHT at the earliest to meet the water demand. Two of the PAP's (Ms. Chinnaponnu & Mr. Alagurathinam), who will be losing their houses due to the construction of OHT requested for assistance</p> | <p>PIU have assured that the PAP's shall be provided with appropriate compensation as per the RP provisions</p> |  |
| 3. | <p>OHT# 19 OHT location:Vaalaithoppu Corporation Ground G. Kumar, Arumugam, V. Jayarani, Pandiamma, A. Kalieeswari, M. Pooppandi, R. Senthooorpand, A. Kalleswari, N. Katturaja and S. Murugan</p> | <p>The local community have requested the PIU to construct the OHT and to provide water supply at the earliest</p> | |  |
| 4. | <p>OHT# 21 OHT location: Meenakshi Nagar L. Nagaraj, S. Vargeeshbabu, S. Kannan, Shanthi, Mary, M. Savarimuthu, Lakshmanan, A. Andisami and Kuruvammal</p> | <p>The local community have requested the PIU to construct the OHT and to provide water supply at the earliest For the PAP's who are losing the structures are requested for appropriate compensation.</p> | <p>It was assured by the PIU that the PAP's shall be compensated as per the provisions given in the RP</p> |  |

| S.No | Participants | Outcome of the Consultation and Discussions | Response from PIU | Photographs |
|------|---|--|--|--|
| 5. | <p>OHT# 22 OHT location: Slaughter House</p> <p>J. Karthikarani, M. Lakshmi, S. Muthulakshmi, J. Hemathangam, M. Pandi, K. Nagenthiran and M. Mugesh Kumar</p> | <p>The local community is purchasing water from vendors/ third party and hence they have welcomed the project and have requested the PIU to implement the same at the earliest to avoid purchasing of water. They have also requested for sewage drain facility.</p> | <p>The PIU have indicated that the requirement for the drainage shall be provided through some other scheme, which is in the pipeline</p> |  |
| 6. | <p>OHT# 35 OHT location: Island Nagar</p> <p>M. Ramu, C. Vetrivel, M. Navaneeth, M. Ramkumar, PA. Muthupandi, S. Balamurugan, C. Dhayalammal, D. Jenifer, R. Rathinam, S. Yasmai and Thangam</p> | <p>One of the PAP have stated that he is a fisherman depending on the nearby water tank for fishing. However, due to the scarcity of water in the tank, he opted for an alternate job (mosaic polishing). Due to his absence, his house was demolished without prior information/ notice.</p> <p>Few of the local community members have requested for an approach leading to the nearby temple.</p> | <p>PIU have informed that notice has been issued well in advance for vacating the place. For the loss of the structure, compensation has been provisioned in the RP, PIU have assured that the PAP shall be compensated as per the provisions of RP.</p> <p>The PIU have assured that 2 m width approach road to the temple shall be provided for the benefit of the local people.</p> |  |

| S.No | Participants | Outcome of the Consultation and Discussions | Response from PIU | Photographs |
|------|--|--|---|---|
| 7. | <p>OHT# 38 OHT location: Shenpagathottam</p> <p>A. Varusaimohamed, A. Ninalan and J. Gabriel</p> | <p>The local community have requested the PIU to construct the OHT and to provide water supply at the earliest</p> | |  |
| 8. | <p>OHT# 40 OHT location: Iravathanallur</p> <p>M. Alagarsamy, M. Karunakaran, R. Ganesan, M. Selvaraj, M. Pradeep kumar, R. Rajkumar, A. Ganeshbabu, R. Manjamalai and M. Kasilingam</p> | <p>The local community have requested the PIU to construct the OHT and to provide water supply at the earliest. They have also requested to locate the OHT without disturbing the burial ground</p> | <p>PIU have assured that OHT shall be constructed without disturbing the burial ground</p> |  |
| 9. | <p>OHT# 41 OHT location: ChinnaAnuppanadi</p> <p>K. Abimani, Vinoth, S. Santhosh, Kumar, N. Amir abbas, R. Vasanth, K. Kandavelpandian, D. Karthikeyan, M. Sathasivam, K. J. Lalitha, T.G. Savithiri, Chellammal, N. Uma, E. Kiruba, M. Kannan, S. SanthanaShanthi,</p> | <p>The local community have no objection to the construction of the OHT. However, they have requested the PIU to construct the OHT in such a way not to disturb the children's playing activity.</p> <p>Few have also commented that they don't want to have</p> | <p>It was assured by the PIU that the playing activity will not be disturbed during the construction activities.</p> <p>The PIU have clarified that there is no provision to have borewell in this project. The water shall be sourced from</p> |  |

| S.No | Participants | Outcome of the Consultation and Discussions | Response from PIU | Photographs |
|------|---|---|-------------------------------------|---|
| | I. Sahayarajan and S. Suresh | borewell in that location | Mullaiperiyar dam (not groundwater) | |
| 10. | OHT# 11 OHT location: Arasaradi back side of the pumping station C. Murugesan, S. Periyakarupan, M. Razesh and E. Nallathambi | The OHT location belongs to the corporation | |  |

Minutes of meeting for “Dedicated Water Supply Scheme for Madurai Corporation from MullaiPeriyar at Lower Camp” held on 15.02.2019

| S.No | participants | Outcome of the Consultation and Discussions | Response from PIU | photographs |
|------|--|---|---|---|
| 1. | OHT# 4 OHT location: Kattabomman Street (Sivakami Street) M. Alagupandeeswari, I.Meena, C. Vetricodi, B. Nagarathinam, Panju, M. Sulaikabuvi, A. Anis Fatima, V. Pavithra, K. Karpagam, K. Pandiarajan, S. Uma Meenakshi, K. Pushpalatha, B. Dhanalakshmi and R. Malliga | The local community have requested the PIU to construct the OHT and to provide water supply at the earliest. However, due to the presence of a school in the vicinity, they have requested to adopt safety for the school children during the construction period | The PIU have assured that alternate route/way shall be used for the construction of the OHT, which will not disturb the school children |  |

| S.No | participants | Outcome of the Consultation and Discussions | Response from PIU | photographs |
|------|--|---|---|---|
| 2. | <p>OHT# 42 OHT location: GurunatharKoil – Chinnthamani</p> <p>S. Chitra, S. Vijayalakshmi, T. Mary Joyce, P. PandiSelvan, V. SethuMadhavan, S. Ganeshan and V. Ram</p> | <p>The local community have supported the project and requested the PIU to provide compound wall surrounding the OHT for safety purposes.</p> | <p>PIU have assured to provide compound wall / fencing surrounding the OHT.</p> |  |
| 3. | <p>OHT# 25 OHT location: Semparuthi Nagar</p> <p>C. Prasath, P. Jeyaprakash, P. Nagajothi, S. Shanthi, K. Maheswari, A. Gayathiri, A. Sakthivel, Sam George, M. Hemalatha, R. priya, R. Raja, M. Gurusamy, R. Lakshmi and K. Muthulakshmi</p> | <p>The local community have supported the project and requested the PIU to construct the OHT.</p> | |  |
| 4. | <p>OHT# 27 OHT location: Alangulam Lake</p> <p>C. Ganesan, R. Saminathan, Muthu K. Prakash, G. Balamurugan, G. Selvam and V. Selvam</p> | <p>The local community have supported the project and requested the PIU to construct the OHT. However being an water catchment area (water body), they have suggested to locate the OHT in such a way not to disturb the water flow (to and fro) from the water body</p> | <p>In order to meet the community demand, the PIU have assured to construct the OHT near to an existing OHT, so that the water body shall not be disturbed.</p> |  |

| S.No | participants | Outcome of the Consultation and Discussions | Response from PIU | photographs |
|------|---|---|--|--|
| 5. | <p>OHT# 31 OHT location: Thiruppalai (Chakra Nagar)</p> <p>Fatima khan, Meera maiden, P. Meena and P. Parvathi</p> | <p>The local community have supported the project and requested the PIU to construct the OHT.</p> | |  |
| 6. | <p>OHT# 32 OHT location: EB Colony</p> <p>P. Manimaran, P. Premalatha, S. Steeladevi, Arammal, S. Senthilvel, V. Pirathaban, Karuppasamy, P. Arivalagan, T. Jeyakodi and P. Madasamy</p> | <p>The local community have supported the project and have requested the PIU to construct the OHT.</p> | |  |
| 7. | <p>OHT# 33 OHT location: Naganakulam</p> <p>T. Anandan and A. Rajendran</p> | <p>The local community have supported the project and requested the PIU to construct the OHT. However being an water catchment area (water body), they have suggested to locate the OHT in such a way not to disturb the water flow (to and fro) from the water body</p> | <p>In order to meet the community demand, the PIU have assured to construct the OHT near an existing Pumping station, so that the water body shall not be disturbed.</p> |  |

| S.No | participants | Outcome of the Consultation and Discussions | Response from PIU | photographs |
|------|--|--|---|--|
| 8. | OHT# 34 OHT location: Bharath Nagar P. Muthuraman, P. Moorthy, J. Hasanbanu and A. Chellama | The local community have supported the project and requested the PIU to construct the OHT. | |  |
| 9. | OHT# 37 OHT location: Poriyalar Nagar Naveen Yasav, M.A. Shanmugam, K. Karuppiyah and S. Vijayalakshmi | The local community have supported the project and requested the PIU to construct the OHT. However, the community have raised a query regarding the technology used in the construction of the OHT. Because, due to the soil instability one of the house got damaged and it was recently renovated. | PIU have clarified the query with respect to the technology used for the construction of the OHT. |  |

| S.No | participants | Outcome of the Consultation and Discussions | Response from PIU | photographs |
|------|---|---|-------------------|---|
| 10. | <p>OHT# 56 OHT location: Kadachanendhal</p> <p>M. Mariappan, M. Karthikan, Rani Santhi, S. Kamaraj and Indra</p> | <p>The local community have supported the project and requested the PIU to construct the OHT.</p> | |  |