

Environmental Assessment Report of Storm Water Drains Phase-I for Thoothukudi Corporation

EXECUTIVE SUMMARY

INTRODUCTION

Due to rapid changes in 21st century, small and moderate cities in India are developing fast and many such cities civic bodies are now upgraded from status of city Municipal Councils to city Municipal Corporation. For such newly formed corporations, providing storm water management system is becoming necessity to properly drain the storm water which involves comprehensive design. Management of storm water with constructive approach is need of the day.

Government of Tamil Nadu has proposed to implement the World Bank supported Tamil Nadu Sustainable Urban Development Program (TNSUDP) to improve the delivery of urban services. The provision of Storm Water Drains to Thoothukudi is one of the sub-projects proposed to be implemented by the Corporation of Thoothukudi. This component is coordinated by, Government of Tamil Nadu with Tamil Nadu Urban Infrastructure Financial Services Ltd. (TNUIFSL), as the fund Manager.

PROJECT AREA

Thoothukudi is the headquarters of Thoothukudi District. The city lies in the Coromandel Coast off Bay of Bengal. The Thoothukudi City Municipal Council attained the status of Corporation (TCMC) on 5th August 2008 after 142 years of being a municipality. In May 2011 the original limits of the Thoothukudi Municipal Corporation area have been expanded by merging the adjacent 4 Panchayats (viz. Meelavittan, Muthiahpuram, Athimarapatti and Sankaraperi) and Thoothukudi Rural area. This has lead to increase in the city area from previous area of 13.47 Sq.km. to 90.66 Sq.km. This expansion is almost in all sides of old city area except the east part and Storm Water Disposal System is proposed to be undertaken in these areas.

In order to provide storm water drains to the Thoothukudi Corporation, a Detailed Project Report for Phase-I, II, III & IV has been prepared. The Phase-I of this project is proposed to be taken up under Tamil Nadu Sustainable Urban Development Project (TNSUDP) This EA report is prepared for the Phase-I of the proposed storm water drainage for Thoothukudi Corporation. .

An estimated project cost, EMP cost & SIA cost for Phase –I is given below-

Phases	Project cost (Cr.)	EMP cost (Rs.)	SIA Cost
Phase-I	175.68	Construction Phase- 13,45,300 O&M Phase- 1,34,37,070	0.00

EMP cost for construction phase includes bid cost for environmental monitoring & compensatory tree plantation cost which is covered in main project work.

EMP cost for O & M phase includes bid cost for environmental monitoring& desilting of drains.

PROJECT DESCRIPTION

In view of urgency to mitigate the major flooding problems of the city and also in view of the present financial condition of the TCMC and the projects already undertaken by it, it is considered that the corporation cannot take up the entire project for execution at a time, Therefore, the project is proposed to be phased in 4 phases viz. Phase I to Phase IV. Each phase will comprise of several packages so that the works under that phase can suitably be executed by several bids for enabling speedy construction with proper competition.

The total project area is 90.66 Sq.kms which includes the expanded area. The total road length including that of the Highways is 655 kms and the existing drains in the project area is 153 kms.

The project area has been bifurcated into 4 catchments namely Upparu River Catchment, Buckle Canal, Mullakkadu, Periapallam Odai and 25 Sub-catchments draining via creek/sea.

S.V. Kulam, a major water body in the study area has an area of 52.38 hectares and needs de-silting to enhance the holding capacity and improvement works in surplus weir, bund strengthening etc.

A. Priority work which will undertake in phase-I:

- Diversion of North side 3 Odais to Periapallam Odai along NH-45B.
- Diversion of Kalangakari Odai and Kaluthapathai Odai into S.V. Kulam.
- Use of S.V. Kulam as holding pond by de-silting / deepening, repairs / modification of bund / waste weir / outlet arrangement.
- Construction of Channel along Meelavittan Road for S.V. Kulam.
- Diversion of Chengulam Odai to Upparu River along NH-7A.
- Widening of Mullakkadu Odai.

APPLICABILITY OF ESMF

Projects proposed under TNSUDP shall be implemented safeguarding the environmental and social concerns of the development activity. The requirements for ensuring environmental and social safeguards have been stipulated in the TNUIFSL's Environmental and Social Management Framework exclusively prepared for TNSUDP.

The proposed SWD to Thoothukudi involves construction of new storm water drainage network along the road sides to facilitate smooth flow of storm water to subsequent drains/canals, and improvement of existing drains & canals within the right of way of the canals. This project is expected to cause minor impacts temporarily during construction like traffic management, access issues etc and during operation, might cause issues related to maintenance of drains, disposal of silt, flooding issues etc. **Also it requires permission of CRZ Department; hence this project is categorized under E1 category as per ESMF.** The E1 project is similar to the Category A project as World Bank Safeguard Policy and require Environmental assessment to be carried out and management measures be prepared

ENVIRONMENTAL ASSESSMENT

The EA was carried out with an objective to identify and assess the environmental impacts arising out of implementation of the Storm Water Drain Construction and develop an Environmental Management Plan (EMP) to mitigate the identified impacts. The EA involved screening of the project, quantitative and qualitative surveys to collect the relevant information, field visits to the project area, catchment areas, canals, etc. and consultations with the community.

ENVIRONMENTAL REGULATORY REQUIREMENTS

A review of national, state, regional and World Bank environmental laws, rules and regulations relevant to the proposed SWD project indicates that in addition to the safeguard policies of the Bank and construction safety requirements, the project would **require permission to cut the trees (177Nos in Phase I)** that will be cut during the construction phase of the project. Also permission from Tamil Nadu State Coastal Zone Management Authority (TNSCZMA) for the drains comes under CRZ area.

BASELINE ENVIRONMENTAL PROFILE

Rock types found in the area belong to the Khondalite and Charnockite groups and Migmatite Complex of Easter Ghats Super group (Archaean Age). Gypsum, limestone, beach sand, kankar and shell limestone are the economic minerals of the District. Rough stone, Jelly, Gravel, Clay, Earth & Granite are the minor minerals.

Thoothukudi registers the maximum temperature of 39⁰ C and the minimum temperature of 22.6⁰ C. The city receives around **673 mm** average rainfall during a year. The city has a very high humidity being in the coastal sector.

The Ambient Air Quality sampling locations of Thoothukudi corporation area comprise of Residential and Industrial Category. The residential category includes AVM buildings and Industrial Category includes, Raja agencies, SIPTCMC.

The annual average concentration of SO₂ & NO_x was found below under prescribed CPCB standard of 80 & 60 µg/m³ for industrial & residential areas respectively. The highest annual average concentration of Total Suspended Particular Matter levels in industrial area of Thoothukudi Corporation was measured 310 µg/m³ and the annual average concentration of Respirable Suspended Particular Matter exceeds the CPCB standards.

The noise level survey conducted by the TNPCB reveals that noise level exceeded the limits mostly in commercial areas, mainly due to vehicular movement. During festive seasons in Thoothukudi, the noise levels were noted high and particularly during Deepavali it exceeded 100 dB.

The baseline status of surface & ground water quality along the storm water drain has been established through sampling and analysis of various water quality parameters. At ten locations water samples were collected and analyzed for various parameters.

The water quality monitoring was conducted by TWAD Board District Water Testing Laboratory at Manjalneerkayal, Thoothukudi.

From the observations it is seen that most of the parameters are above acceptable limit of BIS 10500:2012 standards. Hence water is not suitable for drinking purpose without conventional treatment followed by disinfection.

Land use pattern map was collected from the Thoothukudi Local Planning Authority, Directorate of Town and Country Planning. The residential areas covers 30.12 %, commercial 3.35 %, industrial 11.51 %, institutional 0.69 %, public & semi public sector 2.06 %, roads 5.77 %, agricultural 2.15 %, water bodies 1.12 % and costal regulation area is maximum i.e. 43.23 %.

Soil is mostly clay sandy and the water table varies between 1 and 4 m below ground level. The city has loose soil with thorny shrubs in the north side and salt pans in the south.

Silt parameters are falling within the concentration limits of compost in **SWM Rules,2016** and Hazardous waste (management & handling) Rule, 1989 and its amendments.

ASSESSMENT OF IMPACTS

The major impacts of the project are expected to be during the construction phase leading air and noise quality deterioration, Health and Safety impacts to the workers and local communities, traffic diversion and utility shifting, access to private properties, back flow of water from the canals, solid waste dumping and disposal of excavated silt from the drains.

The project is expected to lead to cutting of about 177 trees in phase I. The project proposes to carry out compensatory plantation of 10 times the trees that may be lost due to the project. Details of tree cutting are given in below table.

Phase-I

Sr. No.	Name of Drain	No. of trees to be cut
1	NH-45B (E-F-G-H)	62
2	Periapallam Odai (H to H1)	0
3	Kalangkari Odai (E1 to E)	0
4	Kalugupathai Odai (F1 to F)	0
5	Kaluthapathai Odai (G1 to G)	0
6	Kalugupathai Odai (F to F2)	2
7	Kalangkari Odai (E2 to E3)	0
8	Kaluthapathai Odai (G to G2)	13
9	NH-7A/NH-45 B (JKC)	10
10	Mullakadu Odai (S-T)	80
11	Meelavittan Road	10
Total		177

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

In summary, the expected impacts are of small scale, temporary and site specific depending on the implementation of the project and will not exceed the construction and major environmental norms. To mitigate the identified impacts an Environmental Management Plan has been prepared along with specific cost estimated for implementation and is EA report. EMP will form part of the contract document.

Management measures proposed in SWD project are -

Rainwater Harvesting: Rain water harvesting arrangements are proposed to be installed in primary drain during phase I & III. **In phase-I 89 no RWH pits will be constructed.** The rain water harvesting is proposed at 500m distance and it comprises of 150mm dia. bore of about 3.0m depth fitted with PVC slotted pipe and fixing of 1200mm dia. RCC pipe at its upper end just below the ground level. The RCC pipe is proposed to be fitted with filter media to exclude the silt entering into the water table.

Sediment Control: Construct Silt pits only in newly constructed tertiary drains and will be in the form of depression of about 45 to 60 cm for about 1.50 m length in those channels so that the sediments are deposited in the silt pits and settle over there which can be removed periodically.

Solid waste Management: Design of box type drains in RCC with cover on top, MS frame with wire mesh for major drains, flow of storm water through FRP gratings and public awareness programs to minimize the solid waste deposits in the drains.

Flood Management: Measures for effective flood management of the study area are as-

- a) Diversion of outside catchment flow from Kalangakari Odai, Kalugupathai Odai & Kaluthapathai Odai (On the north-west side of the city) along NH-45B to Periapallam Odai Upto Sea. By this proposal reduction of 1560 ha. Catchment area of Buckle canal will be achieved.
- b) Diversion of flow of Kalangakari Odai between portion from NH-45B and Meelavittan village to S.V. Kulam and the capacity of S.V. Kulam will also be improved.
- c) Diversion of flow of Kaluthapathai Odai (between portion NH-45B after the crossing of highway & Pandarpatti) to S.V. Kulam.
- d) Improvements to S.V.Kulam by increasing the holding capacity, improvements to the bunds and diversion of flow to Buckle canal through Meelavittan road by constructing a new surplus weir in S.V. Kulam.
- e) Diversion of flow from Chengulam Odai to Upparu River along NH-45B. This proposal will reduce 2100 Ha catchment area of Buckle Canal.

Thus the partial/ full relief percentage is about 67 % whereas the percentage as compared to the entire flood points of 146 numbers works out to 38%. With small part out of total cost investment the probable relief will be quite good and hence the Phase I work is proposed to be undertaken on priority.

Disposal of excavated earth/ silt: It is envisaged that large quantity of silt would have to be disposed from the drains, canals & Seena Venna Kulam Lake. The excess excavated earth will be conveyed to the existing dumping yard at Tharuvaikulam.

Compensatory tree plantation: Provision has been made for plantation of ten times the number of vulnerable trees. **Under compensatory plantation 1800 trees shall be planted around periphery of Seena Venna Kulam & at Tharuvaikulam in phase I.** Thoothukudi Corporation will carry out the maintenance activities of the plantation.

Traffic management measures: During the construction stage of storm water drain, traffic diversion or management is required. Main objective of traffic management is to maximize the safety of work force, publics living nearby and the travelling public and the second objective is to keep traffic flowing as freely as possible. So the traffic management should be a safe system of work for both operatives and road users.

Major traffic management measures considered are as-

- Material supply and disposal of silt and debris shall be scheduled during non-peak hours to avoid the traffic congestions.
- Construction along major transportation corridor will be completed in time bound manner to reduce impact on travel to public.
- Material carrying vehicles should possess Pollution Under Control certificates
- Traffic diversion and safety sign boards/caution boards shall be installed at worksite.

A detailed environmental management plan has been developed integrating these aspects and also the measures monitoring the implementation of EMP.

The EMP shall be implemented by the TCMC through its dedicated environmental and social safeguards specialists and will submit monthly reports on the status of compliance with the ESMF requirements to TNUIFSL.

STAKEHOLDER CONSULTATION

As part of the preparation of Draft Final Report activities for Providing Storm Water Drains for Thoothukudi Municipal Corporation areas, a Stakeholders consultation meeting was arranged at **Thoothukudi on 19th September 2016 at 4.00 pm** in the corporation marriage hall. The information about the meeting, time and venue were given to all stakeholders well in advance.

A power point presentation was made in local language (Tamil) in order to make them understand about the project, aware of the impacts and also to make them feel free to express their own suggestions and views.

The meeting was chaired by the Honorable Mayor, Thoothukudi City Corporation Mrs. Antony Gracy. All AEs of different department of corporation, AEE & AE of PWD Thoothukudi including 121 persons from different categories of social and economical groups were present. Some Councilors, NGOs and other social dignitaries were also attended the meeting.

Most of the stakeholders mentioned that they were affected severely by the inundation during the rains in 2015. They welcomed the project stating that they expect that the flooding would come down with the implementation of the SWD project.

SOCIAL IMPACT ASSESSMENT

As per the revised/updated SIA for phase-I based on the joint field visit and change in the alignments, design and construction methodology, this sub-project is not involving acquisition of private land, displacement and no R&R is envisaged. Hence this sub project is classified as **S3 category as per ESMF**.

DISCLOSURE OF EA

The final version of EA will be available in the websites of TNUIFSL **www.tnuifsl.com** and Corporation of Thoothukudi **www.thoothukudicorporation.com**

CHAPTER 1 - INTRODUCTION

1.1 PREAMBLE

Due to rapid changes in 21st century, small and moderate cities in India are developing fast and many such cities civic bodies are now upgraded from status of city municipal councils to city Municipal Corporation. For such newly formed corporations, providing storm water management system is becoming necessity to properly drain the storm water which involves comprehensive design. Management of storm water with constructive approach is need of the day.

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In order to provide storm water drains to the Thoothukudi Corporation, a Detailed Project Report for Phase-I, II, III & IV has been prepared. The Phase-I of this project is proposed to be taken up under Tamil Nadu Sustainable Urban Development Project (TNSUDP) This EA report is prepared for the Phase-I of the proposed storm water drainage for Thoothukudi Corporation. .

Table No. 1.1 Project cost, EMP cost & SIA cost of Phase-I

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EMP cost for construction phase includes bid cost for environmental monitoring & compensatory tree plantation cost which is covered in main project work.

EMP cost for O & M phase includes bid cost for environmental monitoring & desilting of drains.

TNUIFSL has appointed M/s Suncon Engineers Pvt. Ltd. as the consultant for preparation of Detailed Project Report (DPR) for storm water drains in Thoothukudi Municipal corporation area. This report is for the phase-I's works of the project, which will be funded by PDGF. The aim of consultancy assignment is to design suitable storm water drainage infrastructure, scientifically collect the storm water and dispose it safely.

1.2 ENVIRONMENTAL AND SOCIAL MANAGEMENT FRAMEWORK (ESMF):

Projects proposed under TNSUDP shall be implemented safeguarding the environmental and social concerns of the development activity. The requirements for ensuring environmental and social safeguards have been stipulated in the TNUIFSL's Environmental and Social Management Framework exclusively prepared for TNSUDP.

The proposed SWD to Thoothukudi involves construction of new storm water drainage network along the road sides to facilitate smooth flow of stormwater to subsequent drains/canals, and improvement of existing drains & canals within the right of way of the canals. This project is expected to cause minor impacts temporarily during construction like traffic management, access issues etc and during operation, might cause issues related to maintenance of drains, disposal of silt, flooding issues etc. Also permission of CRZ Department is required, hence this project is categorized under E1 category as per ESMF. The E1 project requires Environmental assessment to be carried out and management measures be prepared.

1.3 OBJECTIVE

The objective of this EA for SWD proposed to Thoothukudi Corporation is to identify and assess the environmental impacts arising out of implementation of the Storm Water Drain Construction and to prepare necessary Environment Assessment Report and mitigate the impacts through Environmental Management Plan (EMP).

1.4 SCOPE

The scope of this Environmental Assessment (EA) is to study the baseline of Environmental status of the project area, assess the impacts from the project implementation, identify issues through FGDs, consultations, prepare management plan, and making necessary provision in cost estimates and bid documents.

This EA is prepared in line with the Environmental and Social Management Framework (ESMF) of TNUIFSL specifically evolved for the proposed Tamil Nadu Sustainable Urban Development Project (TNSUDP).

1.5 METHODOLOGY

- In the screening stage, it is decided whether particular project is required to decide whether an EA is required and focus on projects most likely to have significant impacts, those where impacts are uncertain and those where environmental management input is likely to be required. In the present scenario, the storm water drainage system projects are excluded from the Environmental Clearance (As per Ministry of Environment and Forests (MoEF) Notification issued on 14th September 2006 as amended). However, there is a need of environmental assessment prior to undertake any developmental activity to predict the environmental impacts, if any, due to implementation of the proposed activity and for eliminating or lessening the impact.
- Quantitative and Qualitative surveys were conducted and relevant information was collected, analyzed and compiled to prepare Environmental Assessment Report, wherein the issues before, during and post project implementation will be addressed in view of environmental impacts owing to the proposed implementation of the project.
- The baseline information was collected during the field trips from local offices and from community. During Field Visits, Transect Walks were conducted through project area, catchment areas, canals, etc. and data was collected through observation and FGDs with the community.

- As far as Scoping of the EIA is concerned, seven environmental components viz.air, noise, water, land, biodiversity, soil, aesthetic and the proposed project activitiesunder SWD to Thoothukudi have been taken into consideration for impactassessment.

1.6 STRUCTURE OF THE EA REPORT:

- First section provides an introduction to the project and report.
- Second section briefly explains the project setting.
- The third section provides the project description for the SWD project tothe Thoothukudi Corporation.
- The fourth section provides a review of the regulatory requirements
- The fifth section covers baseline environmental status
- The impacts from the proposed project activities on the environmental baselineare discussed in the sixth section.
- Environmental Management Plan (EMP) with necessary costs and budgetprovisions are provided in section seven.
- Section eightprovides Benefits of Project.
- Section nine provides a brief on the stakeholder consultation and community participation

CHAPTER 2 PROJECT BACKGROUND

2.1 HISTORY OF THOOTHUKUDI

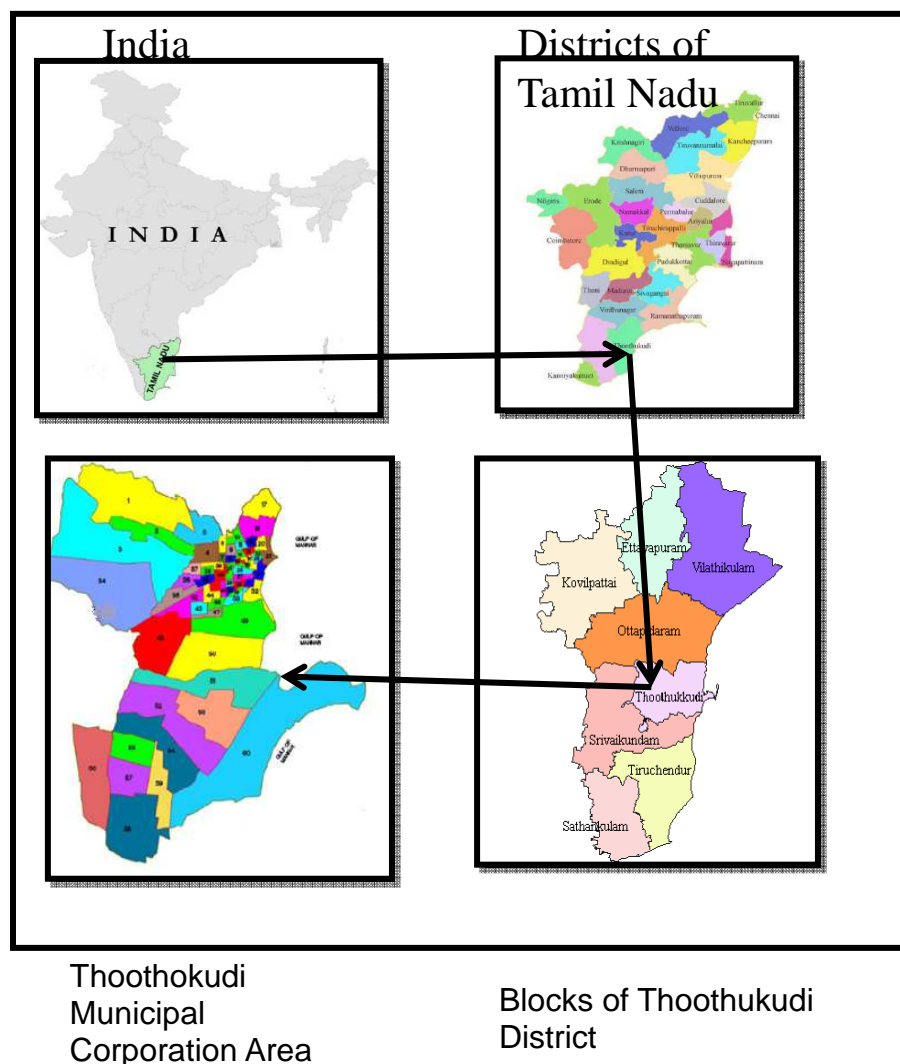
Thoothukudi is also known by the name 'Muthu Kuzhithurai'. It is also called as "Sea Gateway of Tamil Nadu". Thoothukudi is part of the Pearl Fishery Coast, and is known for its pearl fishing and shipbuilding industries. Thoothukudi was the seat of Portuguese during the 16th century, and the Dutch occupied in the 17th century as evidenced by Pagoda coins. During the 18th century the British overpowered and occupied the town. Being a port town, the town received attention from the rulers for improving their trade, and so it was brought to Municipal status in 1866.

2.2 LOCATION OF THOOTHUKUDI

Thoothukudi district is situated in the south-eastern corner of Tamil Nadu. It is bounded on the north by the districts of Tirunelveli, Virudhunagar, and Ramanathapuram, on the east and southeast by the Gulf of Mannar and on the west and southwest by Tirunelveli district.

Geographical location of Thoothukudi is at 8.53°N 78.36°E. It is located about 590 kilometres south of Chennai and 190 kilometres northeast of Thiruvananthapuram (Trivandrum).

Fig. 2.1 Location of Thoothukudi Municipal Corporation Area



2.3 CORPORATION OF THOOTHUKUDI

The city lies in the Coromandel Coast off Bay of Bengal. Thoothukudi is the headquarters of Thoothukudi District. The Thoothukudi City Municipal Corporation (TCMC) attained the status of Corporation on 5 August 2008 after 142 years of being a municipality. In May 2011 the original limits of the Thoothukudi Municipal Council area have been expanded by merging the adjacent 4 Panchayats (viz. Meelavittan, Muthiahpuram, Athimarapatti and Sankaraperi) and Thoothukudi Rural area. This has led to increase in the city area from previous area of 13.47 Sq.km. to 90.66 Sq.km. This expansion is almost in all sides of old city area except the east part.

The Town has been divided into 60 municipal wards with four municipal administrative zones as tabulated below.

Table No. 2.1 Corporation Zones & Wards Included

Zone Name	Ward numbers in the Zone	Number of Corporation Wards
East	14 to 16 & 19 to 33	18
West	34 to 47	14
North	1 to 13 & 17, 18	15
South	48 to 60	13
Total		60

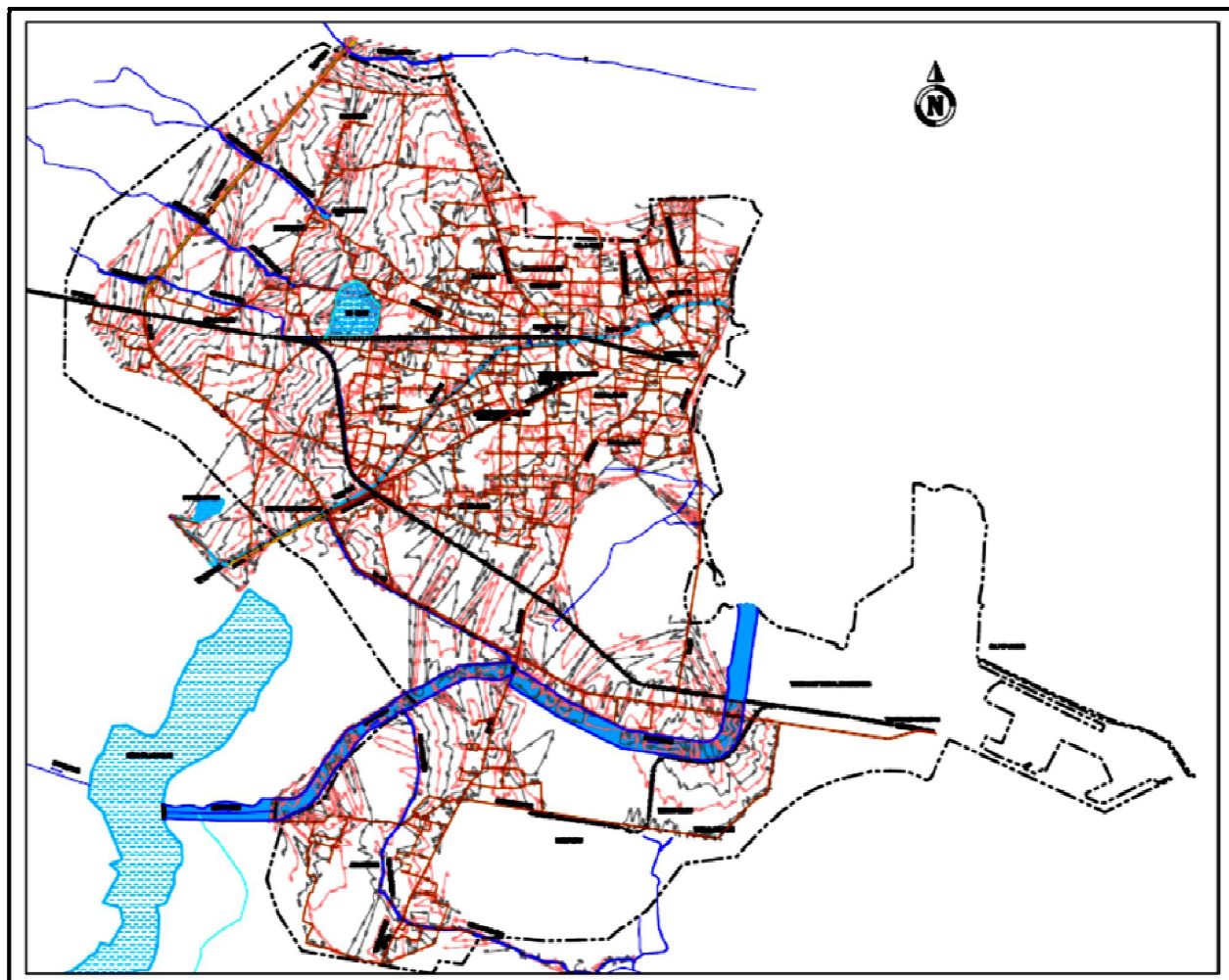
2.4 DEMOGRAPHICS

Thoothukudi was a port town during the period of Portuguese, Dutch and British in the 16th–19th centuries. The city expanded after 1907 due to the presence of public establishments. Residential and industrial growth was maximum around Palayamkottai and Ettaiyapuram roads between 1907 and 1930.

According to 2011 census, Thoothukudi city had a population of 237,830 with a sex-ratio of 1,010 females for every 1,000 males, much above the national average of 929. The average literacy of the city was 83.85%, compared to the national average of 72.99%. The city had a total of 60,714 households.

2.5 TOPOGRAPHY

Thoothukudi is situated at 8.53°N 78.36°E. Thoothukudi is a port town situated in the Gulf of Mannar (part of Bay of Bengal) about 125 km North of Cape Commorin and its environs form part of the coastal belt which forms a continuous stretch of the flat country relieved here and there by small rock outcrops. The region, surrounding Thoothukudi is liberally dotted with rain fed tanks. The bay formed by the Hare Island, Devils point and the main land gives ample protection to the lighters from monsoonal weather. The beach of Thoothukudi is featured with calm breeze and very low waves giving an image of a big river. The city has gentle slope from west to east, i.e. towards sea in the portion on north side of Upparu River. Highest level is RL 19.0 near the Sterlite Industry on North-West boundary and lowest point is RL -0.05 near sea (low tide level). Thoothukudi falls under the Class III Seismic Zone.

Fig. 2.2 Topographic Map of Thoothukudi Municipal Corporation Area

2.6 EXISTING STORM WATER DISPOSAL SYSTEM

In Thoothukudi Municipal Corporation area, there is no properly designed storm water draining arrangement except the buckle canal. The buckle canal is constructed in recent past to carry the stormwater and also the waste water of the original TCMC limits. The old part of TCMC has only the roadside drains. Those drains and the buckle canal carry large quantity of waste water, sullage, sewage and untreated effluents from various localities/ habitations situated along its banks and also from the other parts of the city. All the filthy water flowing in the drains and buckle canal finally finds its way into the creek or sea. One major reason for formation of pools of water into the road side drains is that the drains have inadequate bottom slope due to the very flat terrain of the city due to its situation on the banks of the sea shore. Due to this, the drains have not only lost the purpose of effective draining of the flow, but also have become a source of nuisance causing environment degradation due to stagnated sullage pools during dry weather flow conditions. Most of the drains are open type without cover from the top due to which the dry waste in the form of paper and plastic waste further obstruct the flow.

All these factors give rise to harmful obnoxious odor. The extended areas of the TCMC do not have adequate properly designed storm water drains. This leads not only to flooding and water logging in

low lying areas but also causes environmental degradation. There are about 4 local odais in these extended parts of the city, but due to developmental works taken on the courses of two out of the four odais in the developed part of the city, the storm water flow of those odais leads into flooding of the adjoining areas.

Total length of various types of roads maintained by various departments in the Thoothukudi Municipal Corporation area including Highways is about 655 km out of which, roads having land width of 12 Mtrs or more are about 100 Km. For roads having width of 12 Mtrs or more drains are proposed on both the sides and for smaller roads drains on only one side are proposed. Thus the total length of drains works out to about 660 km. The total length of existing roadside drains in Thoothukudi is about 180 Km. Moreover, those drains appear to have been designed as roadside gutters for disposal of the sullage than to work as storm drains. Therefore, the adequacy of the existing drains will have to be checked while designing the tertiary drains in the subsequent phases of the project and only such drains which are found adequate can be utilised whereas those which are inadequate will be supplemented or replaced with suitable sizes.

2.7 EXISTING PRIMARY AND SECONDARY STORM WATER DRAINS – OVERALL SCENARIO

The details of major primary channels in Thoothukudi City Municipal Corporation area are presented below.

Table 2.2 Major Primary Drains in Thoothukudi Municipal Corporation Area

Drain age Dist. No.	Name of the Primary Drain	Total length/ Length within TCMC limits	Remarks
1	Upparu River	8900m	This river mainly carries water flow from Korum Pallam tank constructed on Upparu river. In addition, SWD of southern TCMC area is disposed in this river.
2	Local creek to North of Upparu River (in Sub Catchment SC-17)	3740m	This is a local creek which originates within city limits and meets sea. SWD of TCMC area on both banks of this creek is carried to sea through this creek.
3	Stream/channel coming from Chengulam Tank upto the flyover bridge of NH45B across the NH7A (length within of the TCMC limits)	1380 m.	Collects storm flow of Chengulam Odai (including waste weir flow of Chengulam Tank located outside of TCMC limit) and drains into Buckle canal
4	Buckle Canal (From assumed chainage 0 below the fly over bridge of NH45B across NH7A	380 m (unconstructed part) + 7170 m (Constructed part). Total 7550 m.	This is artificial storm water drain constructed in RCC flowing through almost centre of the city in south-west to North-east direction through which major storm water within city limit as well as storm water from North side streams outside city limits discharging into Chengulam Tank/ SV Kulam and other areas is conveyed up to sea.
5	Mullakkadu odai	1870 m (Athimarapatti Road Culvert to	From culvert of Athimarapatti Road, odai flows towards Upparu River and on other side of

		Upparu river) and 3104m (Athimarapatti Road Culvert to sea)	culvert, it flows and meets sea.
6	Kalangariodai(Meeting buckle canal near railway crossing)	3930 m (including length through Vaishali Industry and TNEB substation)	This stream originates on North west of city limit and is discharging in to Buckle canal near railway crossing over the buckle canal.
7	Kalugupathai odaion North-East Side of the City near Sterlite finally joining to the S.V. Kulam (Up to S. V. Kulam)	3688 m	Flows upto Sinna Venna lake called as S. V. Kulam. There are no drains beyond S.V. Kulam. S.V. Kulam tank is also not in use due to silting and growth of bushes inside tank and hence, flooding causes in Millavittan area whenever there are excess rains.
8	Kaluthapathaiodai: Stream on North-East Side of the City (on north side of Kalugupathaiodai) previously merging into Shankaraperi tank.	3510 m	Flows upto Sankaraperi area of the city. There are no drains beyond Sankaraperi Tank. Sankaraperi Tank also, is now defunct.Hence, the heavy rainfall causes flooding in Sankaraperi area.
9	Excavated drain along NH45B from its Crossing of NH7A to its crossing of SH176	3500 m	This drain partly serves the flow from the Chengulam lake coming along the NH7A through the culvert across NH7A near the flyover and also serves the adjoining catchment of NH45B along its length of 3500 m. It has width of 11.00m at start with 1.116 m depth, and 21.00 m width with 1.80 m depth at Ch. 3500 m.

Note:

- i. In addition, there are some small drains directly discharging in to creeks/ sea.
- ii. Brief description of all Primary Drains is given as below:

Brief details of primary and secondary Drains:

Corporation limit has one major river viz. Upparu River flowing through it. A natural drain was flowing almost through the centre of the developed part of the city which is now channelized by the TCMC in recent past which is called as Buckle Canal. It has very limited carrying capacity of about 30 cu.m/sec due to channelization. There are 3 odai flowing through the city's northern part but 1 odai (Kaluthapathai) has no water course after Shankaraperi part of the city while the Kalugupathai odai across which the S.V. Kulam is constructed has no water course after about 150 m distance from S.V. Kulam spillway. The third odai viz. Kalangakari odai has its course along the rail track leading to the Chidambaram port and this odai ultimately discharges in to Buckle Canal. In addition, there are 3 to 4 small creeks within the city limits.

i) Upparu River:-

It is the major Primary drain in the project area and is located on western part of the city. The Korampallam tank exist just upstream side of the city limits and is constructed on the Upparu River. After entering into the city limits, the river flows towards East side for initial part and then turns to North before it meets the Gulf of Mannar.

ii) Local Creek to North of Upparu River:-

This is a small primary drain to the North of the Upparu River. It originates within the TCMC limits and flows to North-East side before joining the sea.

iii) Stream/ channel from Chengulam Tank:-

The Chengulam tank is located on west side of the city but outside of the city limits, and is just by the side of NH7A. A nallah/ Stream from the overflow of that tank enters the city limits near the Collector's office and crosses the NH45B below the by-pass road before joining to the constructed part of the Buckle Canal at its starting point.

iv) Buckle Canal: -

Buckle canal (Constructed Part) is flowing through the heart of the city and is the main primary drain of the city. The original width of the buckle canal before its construction in RCC channel was minimum 16.0 m and maximum about 58 m but in recent past the TCMC has constructed the channel in RCC. TCMC has constructed the Buckle Canal of about 7.0 m width and 7170 m. length about 5 to 6 years back. There is a vacant land strip on the side of the buckle canal as the constructed part of the canal is only in part width of the total available land strip. The starting point of the Buckle canal is just at the North of fly over bridge over the railway track on Palayamkottai Road (Thirunerveli Road). The flow from the channel of Chengulam Tank and also the flow coming along the railway track from the North side of the starting point of Buckle canal i.e. from part area of erstwhile Meelavittan Panchayat are admitted in the Buckle canal at its starting point.

This canal is constructed to carry the storm water of major part of the city and also of the upstream areas contributing to the flow into the canal & finally to discharge it into the sea. This is R.C.C. canal with R.C.C. bottom slab & R.C.C. side walls & in most of the length it is without top slab. The canal starts from the 380 m upstream side of the railway track crossing of the Palayamkottai Road (South of P&T Colony) & flows through P&T Colony, Ashok Nagar, Anna Nagar and Rathanapuram and finally meets the Gulf of Mannar in Therespuram area. This Buckle canal has about 6.40 m clear inside width for most of its length except last stretch of about 265 m. at the discharge point near sea where width increases from 19.0 m to 29.0 m. The canal is having silt deposits of few centimeters depth in most of the length while the silting near the end stretch is much more except at the point of joining to sea.

There are several bridges/culverts across the Buckle canal within the city limits to facilitate crossing of the canal.

v) Mullakkadu Odai: -This odai originates within the city limits on the border of the SC 20 and SC21. It has 2 parts (Culvert across the Athimarapatti road is the ridge point for the bifurcation of these two parts), one part flows from culvert to the north towards the Upparu River and has length of about 1870 m. Most of the length of this odai is passing through open fields. The other part having length of about 3100 m flows from the culvert to south and south east direction and after crossing the State highway No 176 i.e. Thiruchendur road, it flows through salt pans and ultimately meets the creek on the south east side.

vi) Kalangakari Odai: Stream on North-East Side of the city: -This stream is on south side of Sterlite Industry. After passing through Vedanta Industry and TNEB transformer yard, it flows parallel to railway track and joins the Buckle Canal near railway crossing.

This stream originates on North West of city limit and carries storm water flow from outside area of 477 Ha (OC 4) to the city storm water system. The stream is finally discharging in to Buckle Canal near railway crossing on Palayamkottai Road (Thirunerveli Road). The stream after entering into the city limits initially flows by the side of the Sterlite industry and then crosses the by-pass road NH45-B and enters into the Vedant Industry. Then it passes through the Vedant industry and through the Tamil Nadu Electricity Board (TNEB) sub- station. Then it crosses the railway track and flows towards south to meet the buckle canal near railway crossing.

vii) Kalugupathai Odai: Stream on North-East Side of the City near Sterlite Industry joining to the S.V. Kulam

This stream is on North West of city. It originates outside of the city limits and has about 185 ha. Catchment area (OC 5) outside of the city limits. After entering into the city limits, it flows on the north side of the Sterlite industry, then crosses the NH 45-B and ultimately ends up in a pond called as S.V. Kulam tank. There is no water course after the S.V. Kulam to dispose of the overflow of the S.V. Kulam. Further, S. V. Kulam is almost silted up and covered by the growth of bushes inside the tank and hence, flooding causes in Kurunjinagar and Muthammal Colony area whenever there are excess rains and whenever water flows over the surplus flow weir of the S.V. Kulam.

viii) Kaluthapathai Odai: Stream on North-East Side of the City joining to the defunct Sankaraperi Tank:-

This stream originates on North west side outside of the TCMC limits. It originates outside of the city limits and has about 489 ha catchment area (OC 6) outside of the city limits. It enters the city limits near the SVK Fuel Station. Then it flows by the side of the Pandarampatti locality and thereafter by the side of a small pond near the Pandarampatti area. Previously, this stream was ultimately ending in the old Sankaraperi tank used as holding pond in past. However, at present, this tank is defunct as the tank area is allotted for development works by the Sankaraperi Panchayat during Panchayat regime, Hence, at present, there is no natural water course available for this stream after the Pandarampatti tank to carry the flow of this stream and hence, its flow causes flooding in Sankaraperi area whenever there are heavy rains.

ix) Drain along the NH45B from NH7A Junction to Junction with SH-176. (On south west side of the NH45B):-

This unconstructed drain is just by the side of the 60 m RoW of the NH45B and appears that it existed before the construction of the National Highway. There is a culvert of size 5.00 m x 2.40 m having carrying capacity of about 40 cum/sec across the NH7A at the starting point to admit part flow of the unconstructed drain on north side of NH7A in which the excess discharge from Chengulam tank flows. This drain is about 3700 m long and has width varying from 1.35 m to 9.75 m and depth from 0.45 m. to 3.00 m. The bed has a slope from north to south. There are container yards & a Fisheries College and Research Institute, etc. on its south side and to facilitate the approach to those establishments, several C.D. works (about 12 numbers) in the form of small bridges are constructed across the drain. This drain serves part of the catchment of the Chengulam Odai and in addition it also drains rain water flow from the adjoining areas to both the sides of the NH45B.

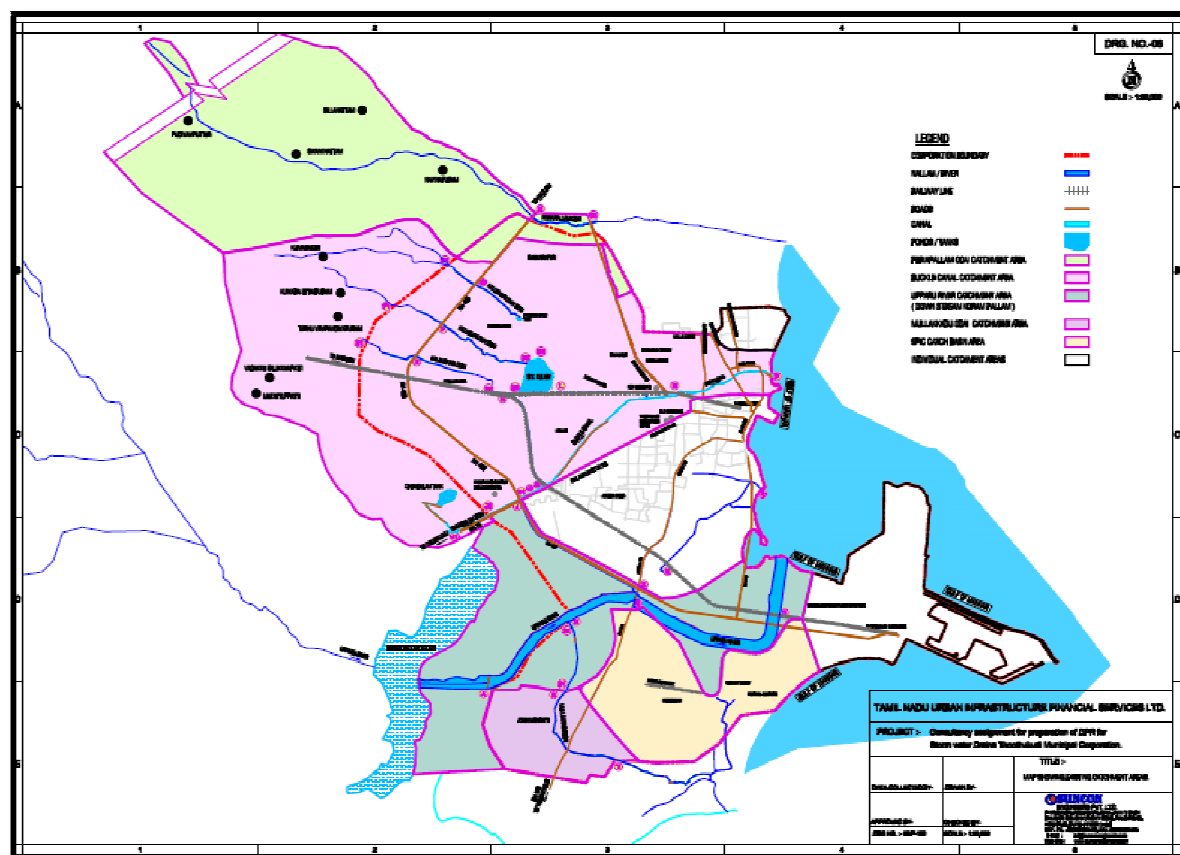


Fig 2.3 Existing SWD system with catchment areas

2.8 FLOODING HISTORY IN THOOTHUKUDI

Incidence of water flooding is a regular phenomenon in many locations in the extended Thoothukudi Municipal Corporation area during rainy season.

However, last year, the city was severely affected during November 2015 floods as compared to history of floods in past. Though the rainfall in Thoothukudi was moderate on 22nd to 24th Nov. 2015, there are instances that when the rainfall in the catchment areas draining into TCMC limits was very high on 3rd Nov. 2015 as compared to that in Thoothukudi which lead to heavy flooding of extended TCMC limits.

Similar flooding was experienced by the city previously in the years 1992 and year 2004 which indicates that the frequency of heavy flood experience for the city is once in about 10 years.

2.9 FLOOD PRONE AREAS IN THE CITY

The details of flood prone areas are identified as 146 no. out of which 22 no. were major with local consultation in the Thoothukudi City Municipal Corporation area are furnished in Table 2.3& 2.4 below. Map showing flood points given in fig. 2.4. Photographs of recent floods are given in fig 2.5.

Table 2.3 Flood prone areas identified in the Thoothukudi Municipal Corporation

Flood Point No.	Name of Flood Affected area	Latitude	Longitude	Description		
				Depth (ft)	Houses (no.)	Duration of flood (in days)
1	Yogeswarar Colony			2	200	1.5 Month
2	Athiparasakthi Nagar	8°49'24.10"	°49'24.10"	3	200	2 Month
3	Thanasekaran Nagar			2	300	2 Month
4	Kasirajan Colony			1.5	150	2 Month
5	Rahmath Nagar	8°49'7.70"	8°49'7.70"	3.5	300	1.5 Month
6	Ram Nagar	°49'10.20"	8°49'10.20"	2	200	3 Month
7	Annai Indra Nagar	8°48'54.34"	8°48'54.34"	1.5	250	1.5 Month
8	Iyyappa Nagar	8°48'48.50"	8°48'48.50"	2.5	500	2 Month
9	Viswapuram	8°48'50.50"	8°48'50.50"	1.5	600	2 Month
10	Devar Colony	8°48'49.60"	8°48'49.60"	2.5	250	1 Month
11	Nethaji Nagar	8°48'52.50"	8°48'52.50"	2.5	500	1.5 Month
12	Rajarathna Nagar	8°49'3.40"	8°49'3.40"	3	20	2 Month
13	Rajiv Nagar	8°47'58.65"	8°47'58.65"	2.5	50	2 Month
14	Chinnakannu Puram	8°48'36.81"	8°48'36.81"	2	200	2 Month
15	Silvarpuram	8°48'51.60"	8°48'51.60"	1.5	700	1 Month
16	V.M.S. Nagar	8°48'43.30"	8°48'43.30"	2.5	1200	1 Month
17	Nikeleasan Nagar	8°48'25.90"	8°48'25.90"	2	150	2 Month
18	Pushpa Nagar	8°48'21.70"	8°48'21.70"	2	100	3 Month
19	Paulpandi Nagar	8°48'11.20"	8°48'11.20"	1.5	400	2 Month
20	Rajagopal Nagar	8°48'28.60"	8°48'28.60"	1.5	1500	1 Month
21	Kurinji Nagar	8°48'50.90"	8°48'50.90"	1.5	1000	1.5 Month
21/1	Dhanasekran Nagar	8°48'50.60"	8°48'50.60"	2.5	300	2 Month
21/2	Periasami Nagar	8°48'39.60"	8°48'39.60"	3.5	120	1.5 Month
22	Muthammal Colony	8°49'0.30"	8°49'0.30"	2	200	2 Month
23	State Bank Colony	8°49'4.50"	8°49'4.50"	1.5	500	2 Month
24	SKSR Colony	8°49'4.50"	8°49'4.50"	2	150	1 Month
25	Arumugasamy Colony			1	100	1 Month
26	Mac Garden	8°49'7.80"	8°49'7.80"	2	200	2 Month
27	Kamaraj Colony			2.5	150	1 Month
28	Housing Board Colony	8°49'18.30"	8°49'18.30"	2	150	1 Month
29	Om Sakthi Nagar	8°49'46.40"	8°49'46.40"	1	100	1 Month
30	Thalavaipuram	8°49'54.20"	8°49'54.20"	2	50	1 Month
31	K.T.C. Nagar (Mullainagar, Kattithangam Colony, E.B. Colony)	8°49'21.80"	8°49'21.80"	1.5	500	2 Month
32	Polpettai (S.K.S.R. Colony, State Bank Colony)	8°48'41.57"	8°48'41.57"	1.5	500	2 Month
33	Sathya Nagar	8°49'3.70"	8°49'3.70"	4	150	1 Month

34	Sundaravelpuram West, Ambethkar Nagar	8°49'8.67"	8°49'8.67"	3	200	1 Month
35	Sundaravelpuram (6/9)	8°49'15.03"	8°49'15.03"	1.5	100	8 Days
36	Nanthagopalapuram West	8°48'41.60"	8°48'41.60"	2	100	8 Days
37	T.M.C. Colony	8°48'43.00"	8°48'43.00"	3	200	1 Month
38	Annai Theresa Meenavar Colony	8°49'28.90"	8°49'28.90"	3	30	3 Week
39	Thasnevis Nagar	8°49'27.10"	8°49'27.10"	4	300	1 Month
40	Iyyar Vilai	8°49'30.20"	8°49'30.20"	3	100	3 Week
41	John Xavier Meenavar Colony			3	100	3 Week
42	Keela Alingarathattu	8°49'41.21"	8°49'41.21"	3	250	2 Week
43	Koilpillai Vilai	8°49'26.71"	8°49'26.71"	3	200	1 Month
44	Mela Alingarathattu	8°49'39.50"	8°49'39.50"	3.5	270	1 Month
45	Packianathan Vilai	8°49'21.90"	8°49'21.90"	2	40	2 Month
46	Pon Subbiah Nagar	8°49'18.64"	8°49'18.64"	2	150	3 Week
47	Indra Nagar			2	150	3 Week
48	Kalainagar Nagar	8°49'25.00"	8°49'25.00"	1.5	200	2 Month
49	Krishnarajapuram	8° 9'28.80"	8° 9'28.80"	1.5	400	10 Days
50	Loorthammal Puram	8°49'33.40"	8°49'33.40"	3	1000	2 Month
51	Mettupatti	8°49'6.80"	8°49'6.80"	2	All Mettu	10 Days
52	Mutharayer Meenavar Colony	8°49'7.70"	8°49'7.70"	1.5	4	8 Days
53	Rajiv Gandhi Nagar	8°48'56.80"	8°48'56.80"	1.5	200	2 Month
54	Sangukuli Colony	8°49'6.10"	8°49'6.10"	1.5	4	8 Days
55	Jeeva Nagar	8°49'23.10"	8°49'23.10"	2	40	2 Month
56	Sivarajapuram	8°49'22.50"	8°49'22.50"	2	150	3 Week
57	Vetrivelpuram	8°49'2.04"	8°49'2.04"	1.5	50	2 Week
58	S. S. Manickapuram	8°49'56.80"	8°49'56.80"	3	15	4 Days
59	Poobalarayerpuram	8°49'4.45"	8°49'4.45"	2	270	2 Week
60	S. P. Office (Threspuram)	8°48'41.00"	8°48'41.00"	2	Office , Cheruch	3 Month
61	Lions Town	8°47'41.14"	8°47'41.14"	2	300	2 Days
62	Thomas Nagar (George Road)	8°47'49.10"	8°47'49.10"	3	150	1 Month
63	Telephone Colony	8°47'51.53"	8°47'51.53"	1.5	20	1 Month
64	P&T Colony	8°47'38.67"	8°47'38.67"	3	100	5 Days
65	Kathirvel Nagar			2	100	5 Days
66	Asirvatha Nagar	8°47'27.10"	8°47'27.10"	2	60	3 Days
67	Madathur	8°47'57.88"	8°47'57.88"	2.5	300	7 Days
68	Elumalaiyan Nagar	8°48'23.80"	8°48'23.80"	2	120	2 Week
69	Kokkur	8°47'55.79"	8°47'55.79"	2	80	15 Days
70	Duraikani Nagar	8°47'25.80"	8°47'25.80"	1.5	50	2 Month
71	College Nagar	8°47'4.31"	8°47'4.31"	4	300	2 Days

72	E. B. Colony	8°47'18.40"	8°47'18.40"	1	12	1 Month
73	New Sundar Nagar	8°47'5.30"	8°47'5.30"	2.5	1000	1 Week
74	Thiraviarathna Nagar	8°47'43.30"	8°47'43.30"	2	270	2 Week
75	Diamond Colony	8°47'11.60"	8°47'11.60"	3	20	1 Days
76	Murugesu Nagar	8°47'39.00"	8°47'39.00"	3	300	7 Days
77	Pasumpon Nagar	8°47'25.40"	8°47'25.40"	3	100	5 Days
78	Kandan Colony			2	130	10 Days
79	Ashok Nagar	8°47'43.79"	8°47'43.79"	2.5	250	15 Days
80	Chinnamani Nagar	8°47'53.23"	8°47'53.23"	2	50	10 Days
81	Chidambara Nagar (Auto Colony)			1	100	10 Days
82	V.O.C. College Kudieruppu	8°47'18.14"	8°47'18.14"	2	180	15 Days
83	Chidambaranagar 4th Street	8°47'44.07"	8°47'44.07"	2	200	10 Days
84	Brayant Nagar 1st Street	8°47'36.08"	8°47'36.08"	1.5	20	10 Days
85	Brayant Nagar 2nd Street	8°47'34.18"	8°47'34.18"	1	40	10 Days
86	Brayant Nagar 3rd Street	8°47'32.29"	8°47'32.29"	2	50	10 Days
87	Brayant Nagar 7th Street	8°47'24.84"	8°47'24.84"	1	30	10 Days
88	Brayant Nagar 8th Street	8°47'23.16"	8°47'23.16"	1.5	50	10 Days
89	Subbaiahpuram 1st Street to 5th Street	8°47'46.42"	8°47'46.42"	1	50	10
90	Indra Nagar	8°47'10.40"	8°47'10.40"	4	1000	8 Days
91	Thiru. V. Ka. Nagar	8°47'13.50"	8°47'13.50"	4	2000	1 Month
92	S.S. Nagar	8°47'5.10"	8°47'5.10"	6	25	3 Month
93	Kirubai Nagar	8°47'9.50"	8°47'9.50"	1	100	1Days
94	Amutha Nagar	8°47'4.20"	8°47'4.20"			
95	Sakthi Nagar	8°46'59.40"	8°46'59.40"	1	1000	10 Days
96	Swami Vivekanantha Colony			2	160	10 Days
97	Muduku Kadu	8°46'7.10"	8°46'7.10"	2	150	2 Week
98	PeriaSamy Nagar	8°46'20.20"	8°46'20.20"	3	200	10
99	Veer Naickan thattu	8°45'19.40"	8°45'19.40"	2.5	160	20 Days
100	Koilpillai Nagar			2	120	1 Week
101	Oorani othaveedu	8°45'38.00"	8°45'38.00"	2	100	1 Week
102	Kadhar Meeran Nagar	8°45'35.30"	8°45'35.30"	0.5	-	2 Days
103	Muthu Nagar	8°45'31.82"	8°45'31.82"	2	100	1 Week
104	Soosai Nagar	8°44'38.40"	8°44'38.40"	2.5	400	1 Month
105	Ponandi Nagar	8°45'8.60"	8°45'8.60"	2.5	100	1 Week
106	Keelatheru	8°45'3.10"	8°45'3.10"	2	300	1 Month
107	Muniasamy Kovil Street	8°45'4.60"	8°45'4.60"	2.5	50	10 Days
108	North Street	8°45'6.20"	8°45'6.20"	4	280	15 Days
109	J.S. Nagar	8°44'44.50"	8°44'44.50"	4	Toatl	3 Week
110	Sundar Nagar	8°44'42.00"	8°44'42.00"	3	500	15 Days

111	Bharathi Nagar	8°44'26.00"	8°44'26.00"	2.5	200	1 Week
112	Ezhil Nagar	8°44'15.20"	8°44'15.20"	2	140	10 Days
113	Kumarasamy Nagar 3rd Street	8°44'21.34"	8°44'21.34"	1.5	150	3 Days
114	Shanthil Nagar	8°44'29.50"	8°44'29.50"	2	500	15 Days
115	Subash Nagar	8°44'30.00"	8°44'30.00"	2.5	100	1 Week
116	Thavasi Perumal Salai	8°44'15.20"	8°44'15.20"	2	140	10 Days
117	Palpannai Street	8°44'31.40"	8°44'31.40"	2.5	10	2 Days
118	Athimarapatti	8°44'31.90"	8°44'31.90"	3	200	2 Week
119	Shanmugapuram	8°44'22.30"	8°44'22.30"	3	50	10 Days
120	Ambethkar Nagar	8°44'10.70"	8°44'10.70"	4	300	15 Days
121	Athiparasakthi Nagar	8°44'4.70"	8°44'4.70"	3	350	1 Month
122	Geetha Nagar	8°44'4.30"	8°44'4.30"	2	125	2 Days
123	Maha Nagar	8°44'7.70"	8°44'7.70"	3	Total	1 Week
124	Sakthi Nagar	8°44'9.40"	8°44'9.40"	2	30	15 Days
125	Santhosh Nagar	8°44'4.92"	8°44'4.92"	3	350	1 Month
126	Thangamani Nagar	8°44'17.10"	8°44'17.10"	2	2000	3 Days
127	Balasankar Nagar	8°44'7.20"	8°44'7.20"	2	150	10 Days
128	Kumarasamy nagar 2nd Street	8°44'21.33"	8°44'21.33"	1.5	150	3 Days
129	Thendral Nagar	8°44'7.98"	8°44'7.98"	2	80	15 Days
130	Kakkanji Nagar	8°43'48.80"	8°43'48.80"	2	150	20 days
131	Nehruji Nagar	8°43'42.50"	8°43'42.50"	3.5	200	10 Days
132	Samy Nagar	8°43'37.60"	8°43'37.60"	3	400	1 Month
133	Gandhi Nagar	8°43'33.80"	8°43'33.80"	1	1000	3 Days
134	Parvathi Puram	8°43'37.00"	8°43'37.00"	2	80	1 Month
135	Nesamani Nagar	8°43'23.40"	8°43'23.40"	2	150	2 Week
136	Ganesh Nagar	8°43'51.36"	8°43'51.36"	3	350	1 Month
137	Indhra Nagar	8°43'33.20"	8°43'33.20"	2.5	70	5 Days
138	Kamaraj Nagar	8°43'54.70"	8°43'54.70"	1	50	1 Week
139	Mahalakshmi Nagar	8°43'50.10"	8°43'50.10"	2	50	1 Month
140	Abirami Nagar	8°44'1.60"	8°44'1.60"	2.5	100	10 Days
141	M. Saveriar Puram	8°43'57.59"	8°43'57.59"	3	150	1.5 month
142	Rajiv Nagar	8°43'52.10"	8°43'52.10"	3	100	1 Day
143	Kebi Street	8°43'55.80"	8°43'55.80"	3	150	1.5 month
144	Ganesh Nagar West	8°43'56.10"	8°43'56.10"	2	50	20Days
145	Labour Colony	8°44'59.30"	8°44'59.30"	2	100	10 Day
146	Sunami Colony	8°44'31.72"	8°44'31.72"	2	120	10 Day

Table 2.4 Major flood prone areas identified with probable reasons of flooding

Sr. No.	Flood Prone Area	Ward No.	Inference about probable reasons of flooding based on survey data
1	Aathiparasakthi Nagar	1	Flooding in this area might have been due to artificial filling and thereby making the Sankaraperi tank redundant and no proper functioning of SV Kulam as holding pond due to its almost entire silting up.
2	Blind School	3	
3	BMC School	3	
4	Kurinchi Nagar	4	
5	Muthammall Colony	5	
6	State Bank Colony Road	6	
7	Thalamuthu Nagar Main Road	18	
8	East Coast Road	11,12,19	
9	Sankaraperi	1	
10	Pandarampatti	2	
11	P & T Colony	34	
12	Near Govt. Medical College	48	No specific reasons regarding flooding in this area can be stated but flooding in these areas seems to be due to clogging of existing storm water drains, silt deposition of buckle canal and unexpected heavy rains.
13	V.O.C. College Quarters	42,43	
14	St. Mary's School	44	
15	V.O.C. Road	51	
16	Near Chandy Matriculation School	53	All these areas were originally part of Athimarapatti Panchayat which is now included in TCMC as per newly extended limit of the city. This area is situated on right bank of Upparu river. This is a low level area adjacent to creek, salt pans etc and average levels are between RL 2.00 to 5.00 M. This area was mainly flooded because of raising of the HFL of Upparu River above the formation level of the Athimarapatti road, when maximum discharge was released from Korum Pallam Dam by opening gates to release maximum flood discharge.
17	Harbour Hwy Ext.	52	
18	Athimarapatti Near A.G. Church	54	
19	Athimarapatti Near CSI Church	54	
20	Athimarapatti Near Sri Venkateshwara Engg. Works	59	
21	Athimarapatti	55	
22	Chandy Polytechnic	54	

Fig. 2.4 Submerged Areas of flood occurred in 2015

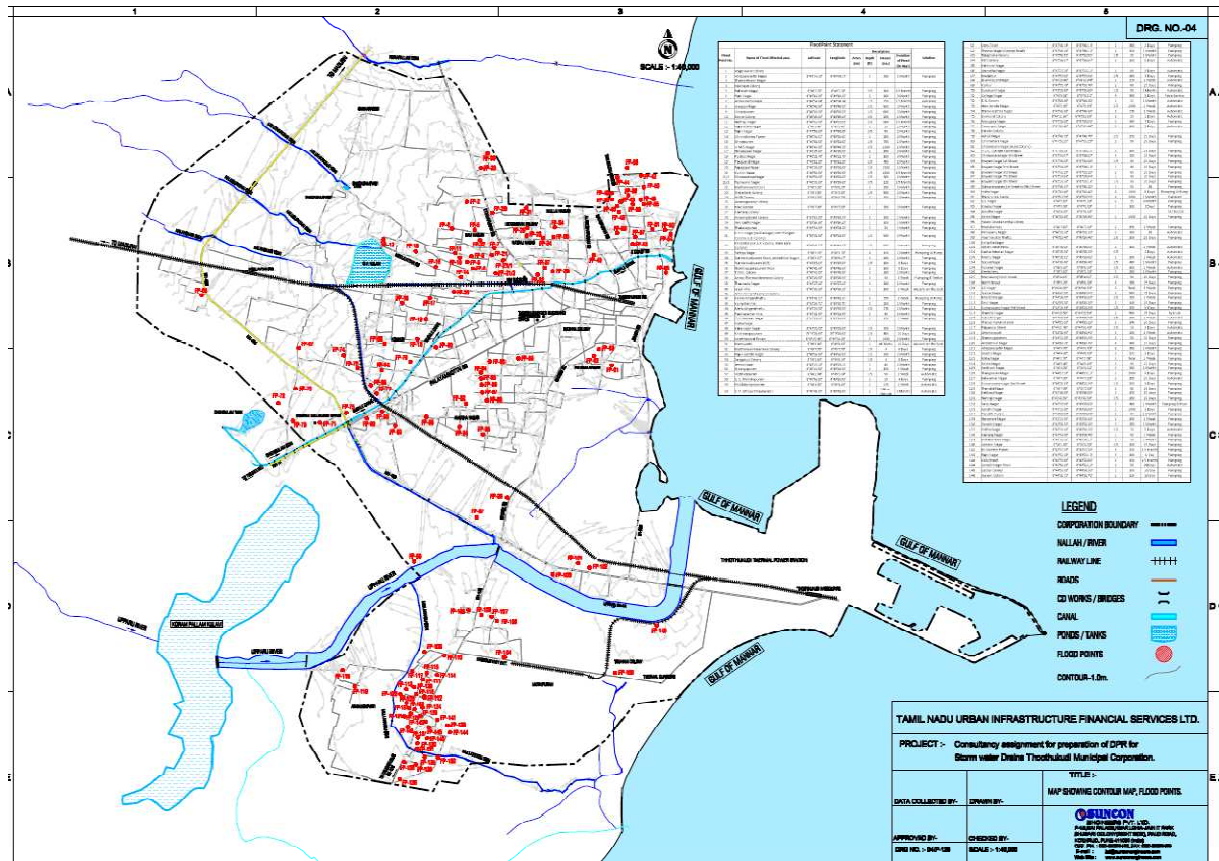
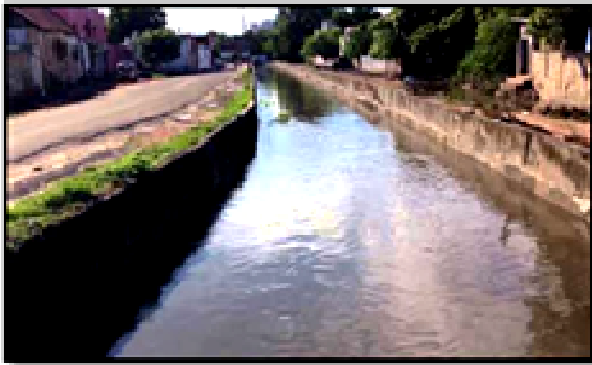
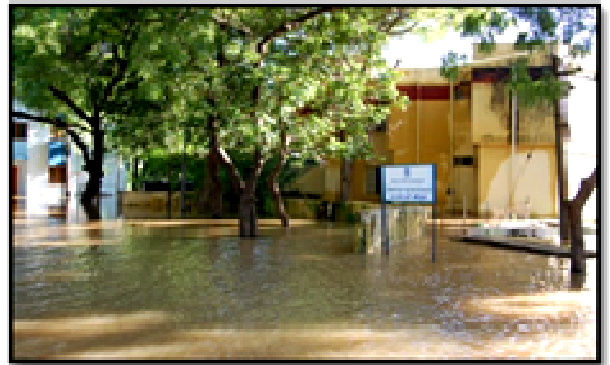


Fig. 2.5 Photographs of Recent Floods



Buckle Canal



Fisheries College & Research Institute Campus



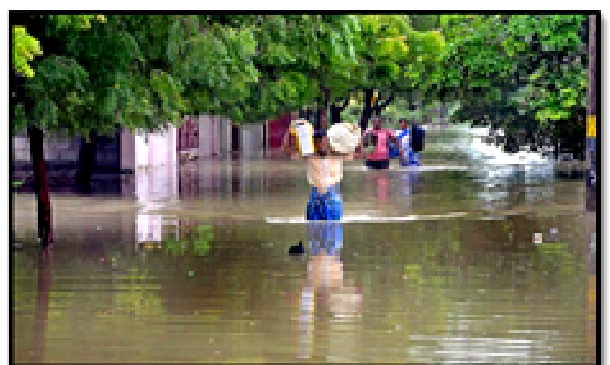
Kurunjinagar



JS Nagar Muthaiahpuram



State Bank Colony



TCMC South Zone

2.10 NEED OF THE PROJECT:

The storm water drainage is a basic need of a modern township. In view of recent flooding in months of November 2015 and Dec 2015 and lacunas in the present system as listed below, it is necessary to take full-fledged storm water drainage project with up gradation of existing system for Thoothukudi town.

- Lack of facility to drain the storm excess from the road network and improper disposal of storm water,
- Absence of road side drains in most of the areas of extended Thoothukudi Municipal Corporation,
- Lack of maintenance of holding ponds leading to encroachments, growth of bushes, silting of lakes due to which most of holding ponds/ structures has mostly abolished.
- Blockages of natural drains / storm water paths due to un-authorized building activities, or lack of interconnectivity between the drains due to new road constructions without Cross Drainage (CD) works / CD works having inadequate carrying capacities.
- Deposition of municipal solid wastes, silt and weed growth in the drains.
- Irregular sections of drain/culvert and drains of inadequate carrying capacity.
- Lack of utilizing Storm Water for Ground Water Recharge.
- Lack of Rain Water Harvesting (RWH) Methods for Open Catchments.

The existing storm water drainage system in the merged area of Thoothukudi City Municipal Corporation is grossly inadequate to meet the growing demands of civic infrastructure needs. For successful functioning of storm water drainage system, it is necessary to design the SWD network in the expanded areas of town with a prime view that it should seamlessly synergize with existing network in the erstwhile municipal corporation area of 13.47 Sq.km.

CHAPTER 3 - PROJECT DESCRIPTION

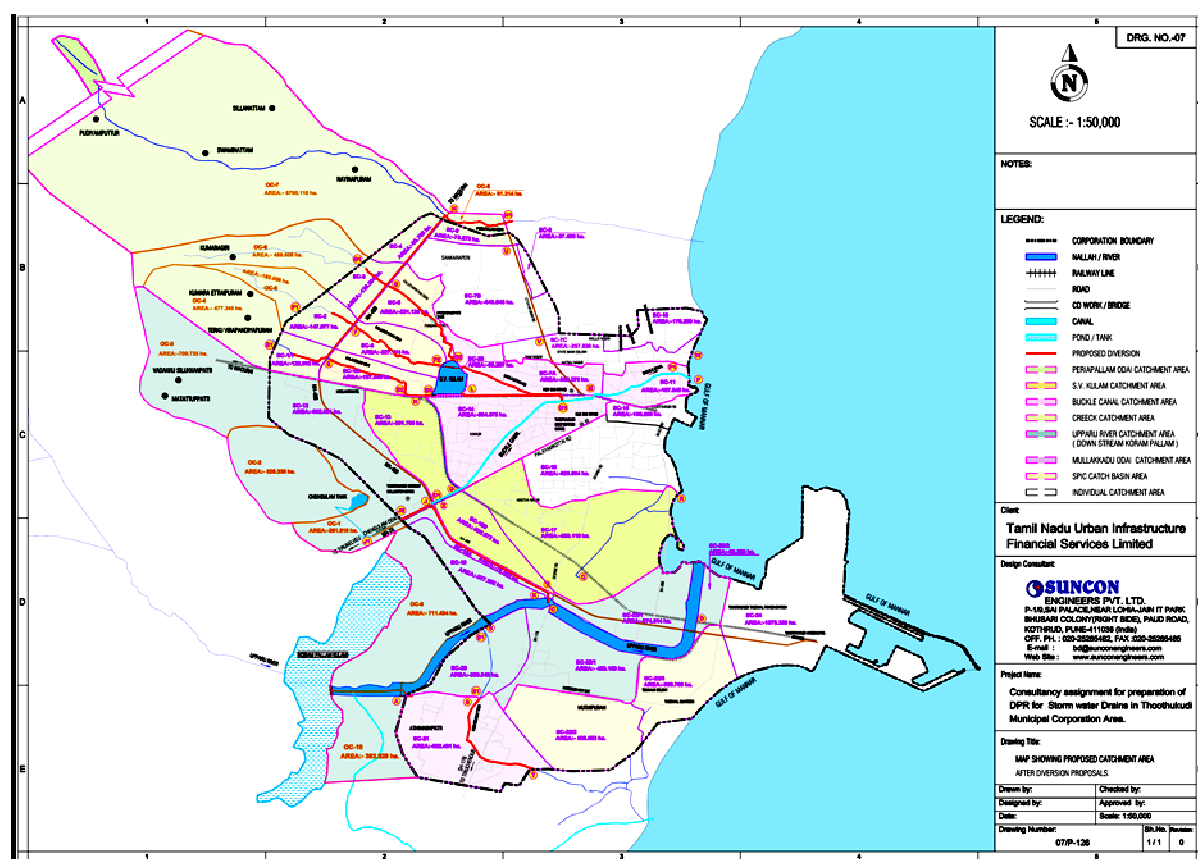
3.1 LIMITATIONS OF EXISTING STORM WATER DRAINAGE SYSTEM

In Thoothukudi, the main primary drain viz. the Buckle Canal has a very limited carrying capacity of about 15 to 30 cum/sec to cater for the design catchment area of 5.50 Sq.km where as the actual catchment area draining into the Buckle canal is 70.42 Sq.km leading to 5 Year critical flow of about 165cum/sec. It is therefore essential to think of some innovative technology to reduce the flow.

3.2 PROPOSED SUB CATCHMENTS

To properly execute the plan whole project work is divided into 25 sub- catchments. Sub-catchments having width more than 1 meter consider for environment report. Map of sub catchment is given in fig no. 3.1 and name of sub catchments are given in table 3.1

Fig. 3.1 Proposed Sub Catchment Map



3.3 PHASES OF PROPOSED PROJECT

In view of urgency to mitigate the major flooding problems of the city and also in view of the present financial condition of the TCMC and the projects already undertaken by it, it is considered that the corporation cannot take up the entire project for execution at a time, Therefore, the project is proposed to be phased in 4 phases viz. Phase I to Phase IV. Each phase will comprise of several packages so that the works under that phase can suitably be executed by several bids for enabling speedy construction with proper competition.

Table No. 3.2: Project implementation schedule of Phase-I(All Packages)

Sr. No.	Phase/ Package	Major works Included
A) Phase-I Works		
1	Package I	Diversion of Kalangakari Odai to Periapallam Odai and allied works (SC-1/1)
2	Package II	Construction of Kalangakari, Kalugupathai and Kaluthapathai odais and diversion to S.V. Kulam (SC-1/2, SC-5, SC-6)
3	Package III	Rejuvenation of S.V. Kulam with strengthening of earthen bund, waste weir and fixing outlet gates and Construction of Mullikulam tank with allied works. (SC-25)
4	Package IV	Construction of Main Storm Water Drain from S.V. Kulam along Meelavittan road and drain towards railway side drain and related works.(SC-7A)
5	Package V	Construction of Storm Water Drain for Diversion of flow of Chengulam Odai to Upparu River and related works (SC-12, SC-18A)
6	Package VI	Construction of Main Storm Water Drain of Mullakkadu Odai and related works (SC-21)
7	Package VII	Procurement of Machinery and equipments for O&M

3.4 SCOPE OF WORK FOR PHASE-I

3.4.1 Diversion of Flow to reduce discharge into Buckle Canal

To reduce the discharge into the buckle canal it is essential to divert part catchment area to other watersheds if such diversion is possible. By adopting this method, the catchment area on the buckle canal will get reduced which will reduce the storm flow also.

The study of the secondary drains in the form of various odai such as Kalangakari, Kalugupathai, and Kaluthapathai Odai indicated that there is no much difference in their bed levels near the crossing of NH-45B. Moreover, the ground level in between those odai is also not very high and it is possible to divert the flows of the 3 odais (without involving high depth of cutting) to the adjoining Periapallam odai watershed which independently discharges to sea without adding the flow of the buckle canal. Hence it is proposed to divert flow of those three odai to adjoining Periapallam odai watershed.

Similarly the flow of Chengulam odai which is presently going towards buckle canal can be diverted to the Upparu River. The Upparu River can accommodate the diverted flow and thereby can reduce the flow of buckle canal.

By considering the innovative method of diversion of catchment area into other adjoining watersheds the flow of the buckle canal can be considerably reduced.

A. DETAILED PROJECT DESCRIPTION -PHASE I

Based on the main report contains the following proposals for providing Storm water drainage Phase I work for Thoothukudi City Municipal Corporation area:

- Construction of Open and Closed primary and important secondary Storm Water Drain System for a designed length of about 22.10.Km along the roads/existing stream course. Same include RCC twin box structures (total 3857 m length along NH7A and 4587 m length along NH45B)
- Construction of 1700 m long wall on left bank of railway drain (from Ch. 100 m to 1800 m) in SC-7A just adjoining to municipal road running parallel to railway track to raise the bank height and thereby to increase the carrying capacity of the natural drain along railway track.
- Construction of a C.D. work across the railway drain near the level crossing of Meelavittan road.
- The work of the construction of the RCC channel of about 4587 m along NH45B and about 3800 m along NH7A includes the following components,

- Nala training works from TCMC outer limit up to the NH 45B for the Kalangakari, Kalugupathai odai and Kaluthapathai odai including bottom concreting and rubble dry masonry to the sides (Total 2162 m length).
 - RCC twin Box channel from Kalangakari odai up to Periapallam odai and allied works.
 - Silt pits at junctions of the 3 odai and RCC box channel
 - Trapezoidal shaped channel from outer limits of the city on NH7A up to the junction of NH45B within the land owned by the TCMC.
 - Extension of existing culverts across the NH7A up to proposed side channels. Connecting channel from those culverts up to chainage 900 m where twin box structure from flyover to Upparu River starts.
 - Construction of about 3800 m length of box structure from chainage 900 up to Upparu River.
- v) As per the hydraulic designs, drains of sizes less than 450 mm width are worked out and those are proposed as Curbs & Gutter arrangements. But such arrangement will be possible while development of the roads and hence no provision for curbs and gutters is made in the project cost though the approximate cost for such works is calculated in the separate sub estimates.
- vi) The bank protection works in the form of stone pitching to the banks of the Periapallam odai is suggested. However, as this stream is under the ownership of the state PWD, it is expected that these bank protection works will be undertaken and executed by the PWD from its own funds and hence no provision for the bank protection works is considered in the project cost of TCMC SWD.
- vii) To utilize the S.V. Kulam as holding pond for temporary storing the flow from Kalangakari, Kalugupathai and Kaluthapathai odai, it is proposed to rejuvenate the said tank by undertaking de-silting, deepening of storage area, raising the height of the bund, repairs of the waste weir arrangement, providing 2 new outlet gates for depletion of stored water, construction of a new C.D. work across the Meelaveetan road passing through the S.V. Kulam as capacity of existing C.D. work is inadequate to pass the maximum flood discharge of Kalangakari and Kalugupathai odai to the spillway etc. and also to construct drain from the Kulam to the buckle canal for discharge of the let out water.
- viii) Additional tank viz. Mullikulam tank is proposed to be used as holding pond as an extension to S.V. Kulam and only the work of construction of a masonry wall (of about 1.20 m average height) in the heart of the tank bund is proposed to arrest flow from the Mullikulam to its outside when the tank reaches the maximum flood level of R.L. 7.10 m. is included in Phase I.
- ix) Construction of Rainwater Harvesting pits (49 nos.) along the Primary/Secondary Channels / Major Drains, 40 nos. in S.V. Kulam water spread area. Thus total 89 RWH structures are proposed.
- x) The estimated project cost for Phase-I works is about **Rs. 175.68 Crore gross.**

Cost Abstract of Phase-I:

Package No	Name of Package	Cost in Crore
I	Construction of channels for diversion of Kalangakari Odai to Periapallam Odai and related works (along NH-45B)	69.66
II	Construction and diversion of Kalangakari, Kalugupathai and Kaluthapathai Odai into S.V. Kulam.	12.20
III	Rejuvenation of S.V. Kulam, improvement to Mullikulam Tank and related work.	11.50
IV	Construction of Main Storm Water Drain from S.V. Kulam along Meelavittan Road and drain towards railway side and related works.	11.60
V	Construction of Storm Water Drain for diversion flow of Chengulam Odai to Upparu River and related work (along NH-7A)	63.87
VI	Construction of Main Storm Water Drain of Mullakkadu Odai and related works.	6.85
	Total	175.68

Table No. 3.3 Proposed Phase-I drain design details

Sr. No.	Name of Watershed	Start Point	End Point	Total Length in M	Proposed Size of Channel		Outfall Discharge for 5 yr. Return Period in Cum/sec	Shape with Material
					Bottom Width	Depth		
1	Proposed Channel for Diversion of Kalangakari odai to Periapallam odai along North side of NH45B							
	Kalangakari odai (Package 1)	Entry point of Kalangakari odai in TCMC limit near Sterlite Industry	Culvert across Kalangakari odai on NH45B	892 m	2.0 to 5.0Mtr	from 2.15 to 2.30mtr	Joins to Diversion channel at NH45B C.D. work	Trapezoidal Sect. with bed concrete and stone pitching to sides.
	Kalugupathai Odai (Package 1)	Entry point of Kalugupathai Odai in TCMC limit	Culvert across Kalugupathai Odai on NH45B	607 m	4.00 to 5.40 m	1.00 to 1.50 m	Joins to Diversion channel at NH45B C.D. work	Trapezoidal Sect. With bed concrete and stone pitching to sides.
	Kaluthapathai Odai (Package 1)	Entry point of Kaluthapathai Odai in TCMC limit	Culvert across Kaluthapathai Odai on NH45B	662 m	5.00 to 5.50 m	1.20 to 2.20 m	Joins to Diversion channel at NH45B C.D. work	Trapezoidal Sect. With bed concrete and stone pitching to sides.
	Diversion channel along NH45B(South Side) (Package 1)	Culvert across Kalugupathai Odai on NH45B	Bridge across Periapallam odai on NH 45B	4587 m	7.0 m total width	1.70 m to 2.34 m	Joins to Periapallam odai at point H. Q=42.88 cum/sec	RCC Twin Box (each box 2.90 m inner width) Structure with cover slab to be used as service road of NH45B
	Periapallam odai (To be done by State PWD)	Bridge across Periapallam odai on NH 45B	Bridge across Periapallam odai on Ettayapuram Road	1600 m	Existing width 15.30 to 18.50	Existing Depth 0.71 to 1.87 m	Joins to creek	Only bank protection with stone pitching proposed. This work to be undertaken by State PWD as the odai is under their ownership.
2	Eastern Side of NH45B to S. V. Kulam							
	a)Kalangakari odai (E-E2) (Package 2)	Exit from compound wall of property south of TNEB substation	S.V. Kulam	625	4.00 m to 5.50 m	0.90 m to 1.50 m.	9.719 cum/sec	RCC Rectangular section
	b) Kalugupathai	East side of Culvert	S.V. Kulam	2590	3.00-	0.86 to	13.69	Trapezoidal Sect with gravel

	Odai (F-F2) (Package 2)	across Kalugupathai Odai on NH 45B			5.50	2.77 m		bottom and stone side pitching.
	c) Kaluthapathai Odai (G-G2) (Package 2)	East side of Culvert across Kaluthapathai Odai on NH 45B	S.V. Kulam	Original odai length = 1789 m	3.45 to 7.75	1.00 to 1.63 m	9.115 cum/sec flow diverted to Mullikulam	The original section with rubble bottom and sides dressed in 1:1 slope. 370 m length of right bank upstream of Pandarampatti entry gate to be raised to R.L. 8.40 m
				Diversion channel from Ch. 1845 m to Mullikula m holding Pond=474 m. Total Length including diversion.	4.50 to 6.00 m	1.40 m	15.02 cum/sec in S.V. Kulam via Mullikulam	The diversion portion in RCC box section with cover slab to sustain traffic loading.
3	Downstream of S.V. Kulam							
	Drain along Meelavittan Road upto railway culvert (Package 4)	Downstream of S.V. Kulam on Meelavittan Road	Odai along Railway track near Chinnakannu Puram	1967m	1.20 to 6.90 m	1.0 to 1.20 m	Drains to existing drain along railway track	Rectangular shape with RCC material
	b) Existing natural drain along main railway track (Package 4)	Downstream of S.V. Kulam near railway track	Stream near K.V.K. nagar joining to buckle canal	2625.47 m	5.0 to 9	1.00 to 1.60 m	9.40 cum/sec (Discharge to Buckle Canal)	Natural Soil material with natural existing shape. For the end 1800 m length of the existing drain will have a masonry wall of 0.24 m to 1.25 m height on left bank just on the edge of railway boundary.
4	Diversion of Chengulamodai to Upparu River (J2-J-K-C)							

	(Package 5)	Municipal boundary on NH7A	Road Bridge of SH176 On Upparu River	Along NH7A= 813.67 m	9.0 to 10.0 m	2.00 to 2.15m	32.55cum/sec (part flow towards Upparu and balance flow to Buckle canal)	Trapezoidal Section with bottom concrete with stone pitching on NH 7A road side i.e. LHS
				Along NH7A= 3662m	7.0 m top and bottom widths	1.95 m	28.22 cum/sec	RCC Twin Box (each box 2.90 m inner width) Structure with cover slab to be used as service road of NH7A
				Along SH-176=13 8m			28.186 cum/sec (Discharge to Upparu River)	---Do-----
5	MullakkaduOdai							
	(Package 6)	Culvert in Athimarpatti area on road joining SH176 to NH7A	Local creek on south side of the city	0 to 1704 m	4.60 to 10.0 m	1.30 to 1.59 mm	6.115cum/sec	Trapezoidal Section with bottom concrete and sides with stone pitching
				1725 to 2579	4.50 to 10.50	1.43 to 1.72 m	11.56 cum/sec	Existing walls are retained & raft is proposed between walls in central bottom portion. New RCC retaining walls are proposed & apron , PCC & sand bedding at central bottom portion. RCC Rectangular C-type section is proposed.
				2579 to 3103.70 m	10.00 m	1.07 to 1.18 m	12.14 cum/sec (Discharge to Creek)	Trapezoidal Section with bottom concrete and sides with stone pitching

Table No. 3.4 Ownership of land & status of permission for Phase-I

Sr. No.	Name of Drain / Proposal	Ownership	Status of Permission
A North side Channels (Peria Pallam Catchment)			
1	Kalangkari Odai Upto NH-45B (E1-E)	TCMC	Permission not required as the work is of TCMC itself
2	Kalagupathai Odai Upto NH-45B (F1-F)	TCMC	Permission not required as the work is of TCMC itself
3	Kaluthupathai Odai Upto NH-45B (G1-G)	TCMC	Permission not required as the work is of TCMC itself
4	Along NH-45B from Kalangakari Odai to Periapallam Odai (E-F-G-H)	NHAI (NH-45B Part)	During meeting with Chief General Manager-NHAI-Madurai Dated: 23.02.2018. he has given concurrence to construct RCC box of 7m wide along NH-45B.
5	PeriaPallam Odai from bridge on NH-45B to bridge on Ramnathpuram (H-H1)	Tamil Nadu PWD	Work will be carried out by PWD itself through this project cost funds else PWD will have to permit TCMC to do the work in their premises.
B Channels for S. V. Kulam Catchment			
6	Kalangakari Odai from NH- 45B to S.V. Kulam (E2-E3)	TCMC	Permission not required as the work is of TCMC itself.
7	Kalagupathai Odai from NH-45B to S.V. Kulam (F-F2)	TCMC	Permission not required as the work is of TCMC itself.
8	Kaluthapathai Odai from NH-45B to S.V Kulam	Part length TCMC(Only for Kaluthapathai length portion and existing cart track), Part length private land	For ownership of TCMC length permission not required as the work is of TCMC itself. For private land , land transfer will be required or consent of land owner will be required.
C Channels for Upparu and Mullakkadu Catchment			
9	Chengulam Odai diversion to Upparu River (J2KC) (Initial 793m along NH-7A further 3840 along NH-7A and end portion of 100m parallel to SH	Initial 793 m length of NHAI along NH7A, further about 3840 m of NHAI along NH-7A and end 100 m existing odai -TNSCZMA	During meeting with Chief General Manager-NHAI-Madurai Dated: 23.02.2018. he has given concurrence to construct RCC box of 7m wide along NH-7A Project Proponent will take CRZ clearance before initiation of work
10	Mullakkadu Odai (S-T)	The existing kutchra drains runs for a	The entire odai is falling under patta lands. Water User Association is maintaining the

		length of 3.1km and the entire odai is falling under patta lands. Water User Association is maintaining the odai in the upstream	odai in the upstream. Require consent letter from WUA.
D	Channels for Buckle Canal Catchment		
11	Drain Along Meelavettan Road from S.V. Kulam to Buckle Canal	TCMC	Permission not required as the work is of TCMC itself.
12	Drain along Railway line from S.V. kulam to Buckle Canal	Existing drain of Railway in Railway owned land is proposed to be used without any additional construction.	No work proposed hence no permission required.

3.4.2 USE OF S V KULAM AS HOLDING POND

In Thoothukudi, there is only one pond/tank presently available to use as a holding pond. This is S.V Kulam which is constructed across Kalugupathai odai but is presently almost silted up. By proposing the de-silting of S.V Kulam and by diverting the flows of other 2 Odai viz. Kalangakari odai and Kaluthapathai odai into S.V Kulam, in addition to existing flow from Kalugupathai odai, it is possible to hold the 5 years frequency flow of these 3 Odais (from catchment d/s of NH-45B to S.V Kulam) for about 24 hours and thus the effect of flow from this catchment area of about 710 ha on the flow of buckle canal can be differed.

3.4.3 REJUVENATION OF S V KULAM

S V Kalam Pond is heavily silted and storage capacity has reduced to almost zero level without any scope for storage in the pond. As a result whole pond is occupied with shrubs, thorny bushes. Area of the pond is about 52.38 Ha.

Process of work to be carried out under Rejuvenation-

- i. Cutting of shrubs from the Pond
- ii. De-silting of Pond
- iii. Strengthening of Bunds
 - Earthen bund will be constructed from inside and outside having length 2.3 km with slope of 1:2 and 1:2.5 respectively.
 - Stone pitching of 450mm thick is proposed from inside sloping portion of bund.
 - It is also proposed to provide 3 Nos. of gates on North & South side with construction of necessary RCC wall in M-25 grade concrete
- iv. Diversion of flow from Kalangakari odai & Kaluthapathai odai into S V Kulam
- v. Beautification of Pond by planting trees at periphery.
- vi. Creation of an island in the pond to support breeding space for birds.

The excavated material will be disposed off at suitable location (At the Tharuvaikulam Ground) as per the direction of Engineer-in-charge.

Table No. 3.5 Measurements of S V Kulam before & after Rejuvenation

Particulars	Before Rejuvenation	After Rejuvenation
Area of Pond	52.38 Hectare	Area to be developed 40Ha. Out of 52.38Ha.
Bund Length	Length of earthen bund: - 2296 m. Length of masonry waste weir: - 90m	2.30 Km
Bund Width	2 to 3m	Av. Width- 7m
Bund Height	1.5m	2.5m
Average Depth of Tank	0.5m	1.4m
De-silted Area	-	40 Ha
Total Volume	Filled up.	5,96,000 Cum.

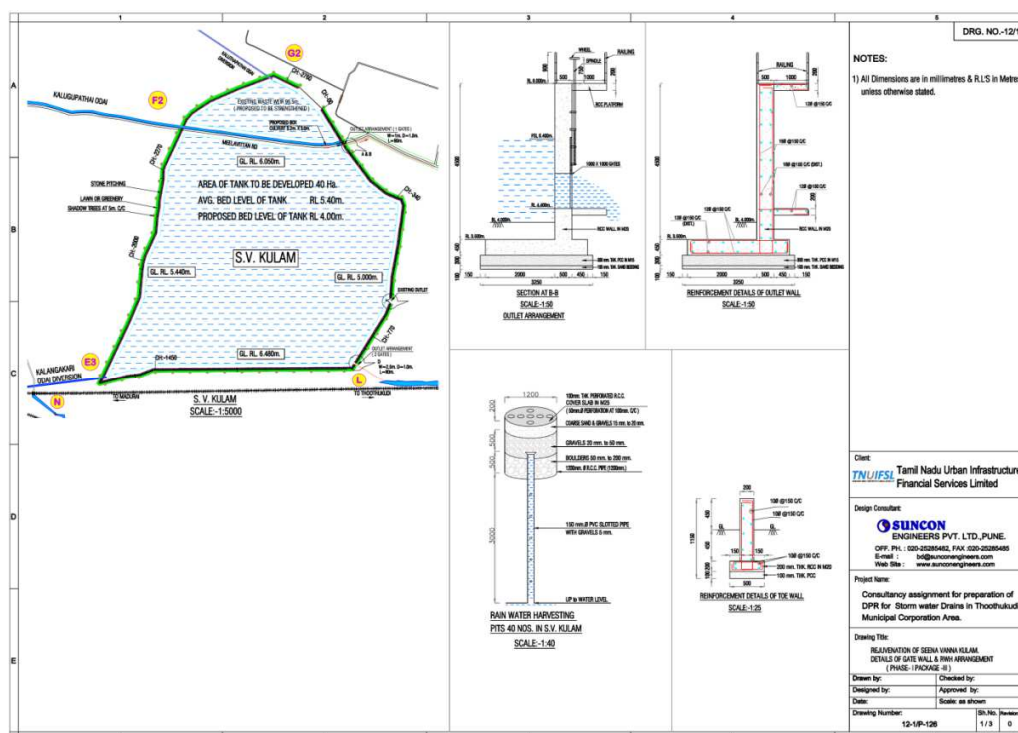


Fig 3.3 Structure of S V Kulam after Rejuvenation

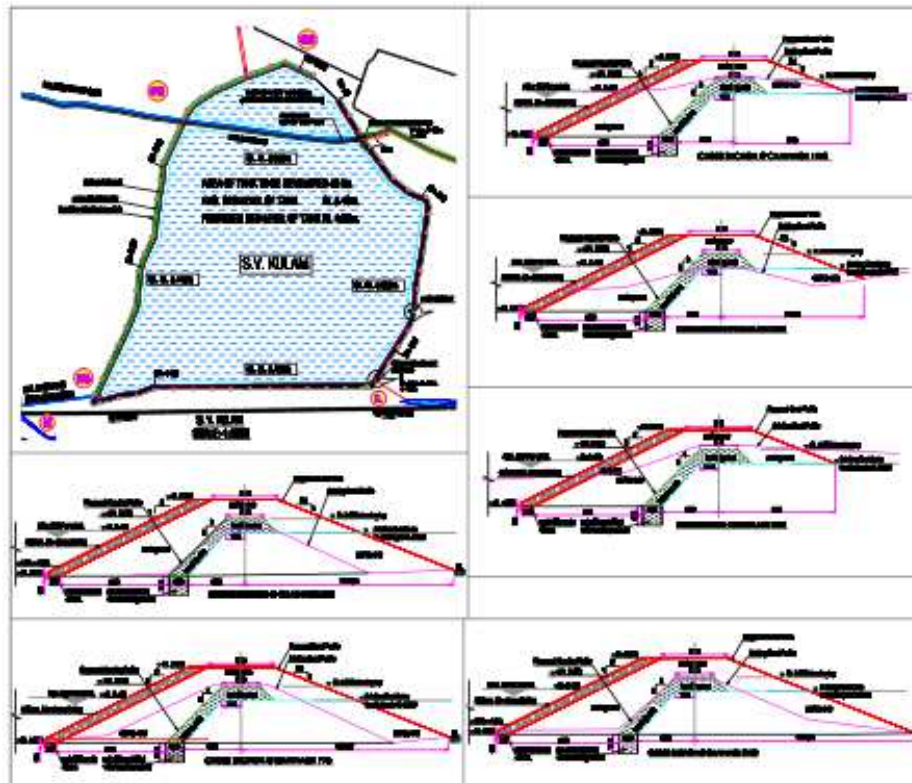
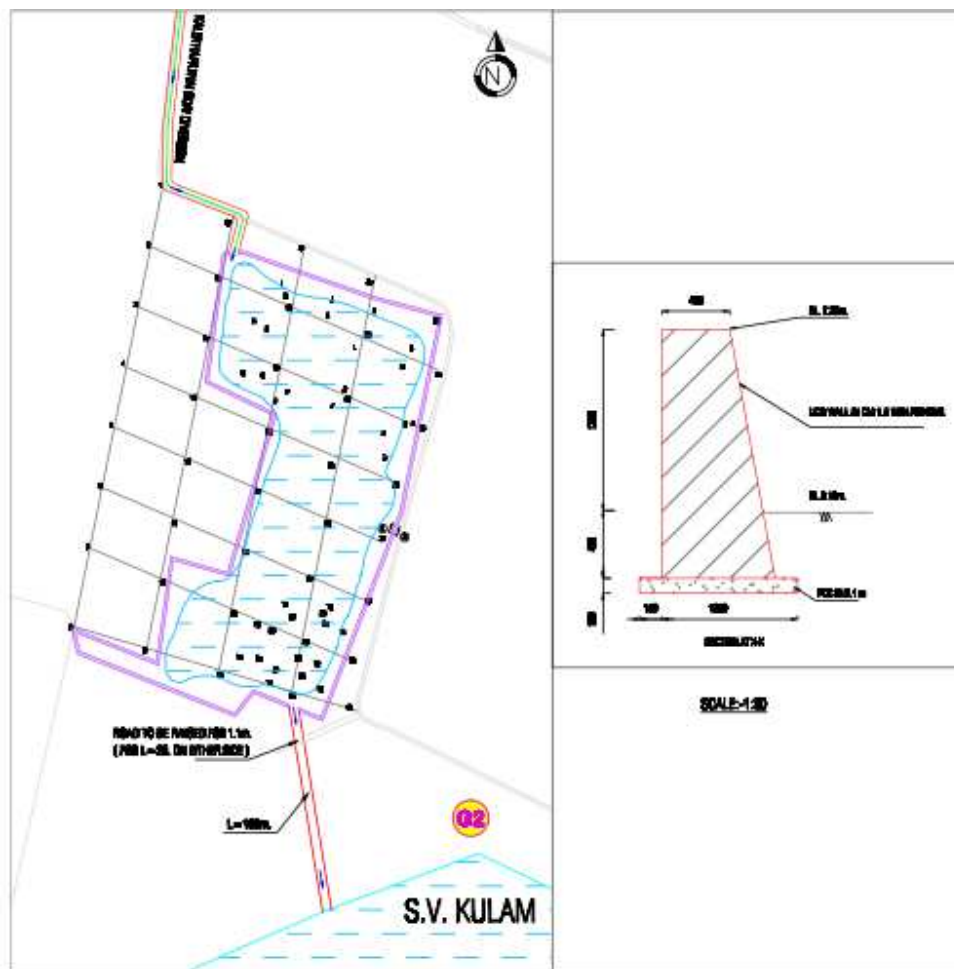


Fig. 3.4 Proposed Raising of Bund

MULLIKULAM TANK:

The top of the proposed bund surrounding the existing 2 ponds of the Mullikulam will be at R.L. 8.00 m and the FSL will be at R.L. 6.40 m while HFL will be at R.L. 7.10 m (Same as those of the S. V. Kulam to work in conjunction). The LWL in the pond will be R.L.4.50 m. Thus all these controlling hydraulic levels will be same as those of the S.V. Kulam. As already mentioned earlier, TCMC is developing the Mullikulam by taking up excavation for the storage and construction of earthen bund (from the excavated material) around the tank. The height of the bund above the ground level is about 1.20 m but the bund is without ant hearting zone. As the natural ground around the bunds has average level of about 6.10 m and as the HFL of Mullikulam) and that of S.V. Kulam will be same due to their interconnection) will be at R.L. 7.10 m., it is proposed to construct a masonry wall of 0.45 m width and 1.20 m height at the middle of the bund by excavating the existing filled material. This wall to be constructed all-round the Mullikulam and will act as a hearting zone and will avoid the flow from the Mullikulam to its outside. Therefore, no cost of construction of Mullikulam tank, except the cost of the proposed all around wall is considered in the cost estimates.

The extra excavated stuff from S.V. Kulam tank will be disposed at Tharuvaikulam ground.



Plan of Proposed works Around Mullikulam Tank

3.5 CONSTRAINTS IN PROJECT IMPLEMENTATION

Details of utilities as LT Pole, HT Pole, DP, Hand pump, Water supply lines coming in the way of proposed chainages is summarized in below table no. 3.6.

Water pipe lines along or crossing the drains will not be disturbed or affected during construction of the proposed drains.

Table 3.6 Details of Utilities coming in the way of Chainages in phase- I

Details of Utility									
S. N.	Name and Package of Odai	Details of Utility				Between Chainages		Length (m)	Remark
		HT Pole (No)	LT Pole (No)	DP (No)	Water Supply Line dia (mm)	From	To		
	Package-I:								
1	Kalangkari Odai Upto NH-45B				250	200	300	7.90	Water pipe line crossing

	(E1 - E)								
					250	300	400	7.90	Water pipe line crossing
					250	300	400	7.90	Water pipe line crossing
					250	500	600	6.60	Water pipe line crossing
		13				0	850		
2	Kalugupathai Odai Upto NH-45B (F1 - F)	-	-	-	-	-	-	-	-
3	Kaluthapathai Odai Upto NH-45B (G1 - G)	-	-	-	-	-	-	-	-
4	Peria Pallam Odai (H - H1)								
5	Primary Drain Along NH-45-B (E - F - G - H)				300	0	4592	4592	Along NH-45B
			10			1700	2300		
	Package-II:								
6	Kalangkari Odai from NH-45B to S.V Kulam (E2 - E3)				300	400	500	4.00	Water pipe line crossing
7	Kalugupathai Odai NH-45B to S.V Kulam (F - F2)				100	1700	1800	7.10	Water pipe line crossing
					75	1700	1800	7.10	Water pipe line crossing
8	Kaluthapathai Odai NH-45B to S.V Kulam (G - G2)				100	1200	1220	7.00	Water pipe line crossing
					300	1220	1240	7.30	Water pipe line crossing
	Package-III: (S.V Kulam)	-	-	-	-	-	-	-	-
	Package-IV:								
	Drain Along Meelavittan Road		26			0	2600		
		76				0	2600		
				3		0	2600		
	Package-V:								
	Chengulam Odai to Upparu River (J-K-C)	1				200	400		
			4			200	400		
					300	0	800	800	Water pipe line Along NH-7A

					150	0	800	800	Water pipe line Along NH-7A
			2			900	1000		
		2				4000	4100		
			1			4500	4600		
			2			4600	4700		
		2				4600	4700		
					450	1000	4600	3600	Water pipe line Along NH-45B
	Package-VI:								
	Mullakkaddu Odai (S-T)				300	0	20	15	Water pipe line crossing
					150	0	20	15	Water pipe line crossing
					75	50	100	15	Water pipe line crossing 4 NOS.
			3			0	100		
			1			200	300		
			4			950	1050		
					200	1400	1450	13.20	Water pipe line crossing
					100	1650	1700	13.20	Water pipe line crossing 3 NOS.
					250	1700	1750	16.40	Water pipe line crossing
					300	1700	1750	16.40	Water pipe line crossing
		2				1700	1800		
			4			1700	1800		
			8			2300	2600		
					100	2550	2600	17.20	Water pipe line crossing
			8			2900	3100		

CHAPTER 4 - REVIEW OF ENVIRONMENTAL REGULATORY REQUIREMENTS, POLICIES & GUIDELINES

4.1 RELEVANCE OF ENVIRONMENTAL LAWS TO TNUDF PROJECTS

The national, state, regional and World Bank environmental laws, rules and regulations relevant to the proposed SWD to Thoothukudi Corporation are provided below:

Table 4.1 Applicability of various Environmental Laws to proposed SWD Project

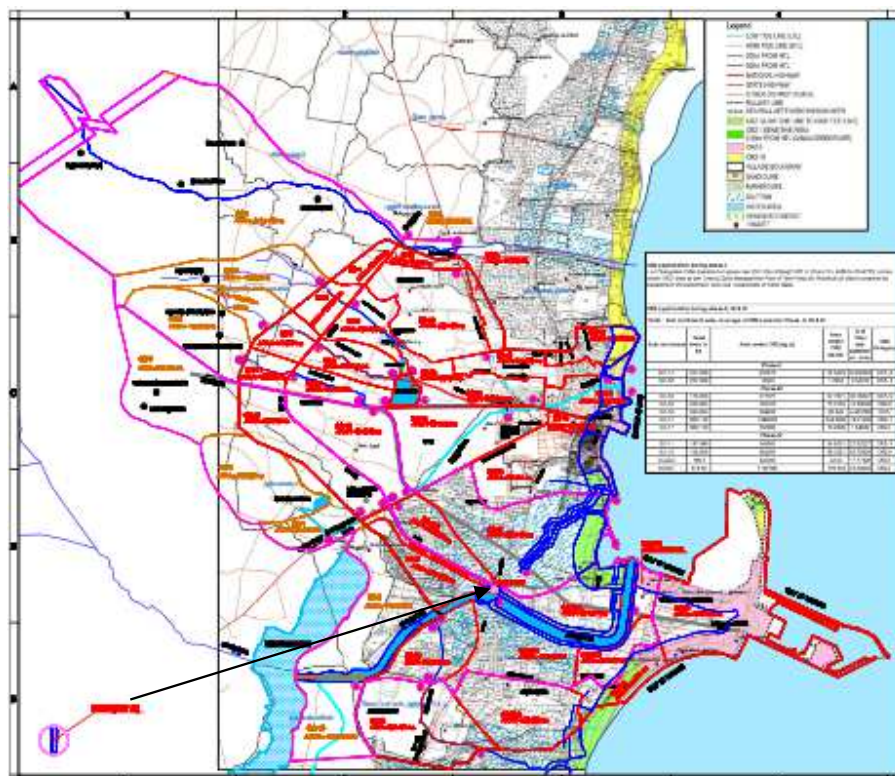
Sr. No.	Acts	Relevance to TNUDF Projects
National		
1	Wildlife Protection Act, 1972	This Act seeks to protect wildlife, by creating protected areas and controlling trade in wildlife products. Project activities that cross over into protected area regimes then requisite permission must be obtained. The SWD to TCMC does not involve any such areas and hence not applicable.
2	Water (Prevention And Control of Pollution) Act, 1974 and Tamil Nadu Water (Prevention And Control of Pollution) Rules, 1974	Under this law, it is mandatory to obtain consent from Tamil Nadu Pollution Control Board (TNPCB) for outlets for discharge of effluents for any municipal projects. Not applicable for the project.
3	The Water (Prevention And Control of Pollution) Cess Act, 1977	This Act provides for levy and collection of a cess by local authorities on water consumed by persons or industries to augment resources for Pollution Control Boards. Not applicable for the project.
4	Forest (Conservation) Act, 1980	Projects with activities falling in reserved forest areas need a clearance from MoEFCC. The project area does not involve any forest area and not applicable.
5	Air (Prevention and Control of Pollution) Act 1981 and Tamil Nadu Air (Prevention of Control of Pollution) Rules 1983	These laws address the prevention and control of air pollution. Under section 21 of this Act, it is mandatory to obtain consent from Pollution Control Board to establish or operate any industrial operation. Applicable, to maintain ambient air quality criteria during construction.
6	Environment (Protection) Act, 1986	Popularly known as EP Act, it is an umbrella legislation that supplements existing environmental regulations. This law essentially links pollution and natural resource issues. Salient features of the Act are the following: <ul style="list-style-type: none"> Section 6 empowers the Government of India to make rules to regulate environmental pollution by stipulating standards and maximum

		<p>allowable limits to prevent air, water, noise, soil and other environmental pollutants</p> <ul style="list-style-type: none"> Section 7 prohibits operations that emit pollutants in excess of standards Section 9 regulates handling of hazardous substances and identifies persons responsible for discharges and pollution prevention <p>General provisions of the act are applicable.</p>
8	Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008	General provisions of the rules to follow the guidelines for handling and disposal of hazardous wastes are applicable to TCMC.
9	Bio Medical Waste (Management & Handling) Rules 1998	<p>The rules lay down the method of collection of hospital waste, its transportation and disposal based on scientific methods.</p> <p>Not applicable for the project</p>
10	Solid Waste (Management & Handling) Rules 2016	This notification by Ministry of Environment and Forest lays down the methods of handling Municipal Solid Waste (MSW) and its scientific disposal. Provisions of the rules are applicable to TCMC.
11	The Noise Pollution (Regulation and Control) Rules, 2000	The ambient noise levels in any area/zone shall not exceed the ambient noise quality standards in respect of noise as specified in the Schedule. The provisions are applicable for the project during construction.
12	EIA Notification, dt 2006 (S.O.1533(E), dt.14/09/2006)	<p>The notification specifies that prior environmental clearance is required for the projects listed in the schedule of the notification before any construction work, or preparation of land by the project management except for securing the land, is started on the project or activity.</p> <p>The project does not attract this notification.</p>
13	Wetlands (Conservation and Management) Rules, 2010	The rules list the list of wetlands that need to be protected like those covered under Ramsar Convention, those in UNESCO heritage site, those which are ecologically sensitive etc and prohibits the certain activities within such wetlands. The project does not involve any such areas and hence not applicable.
14	Coastal Regulation Zone (CRZ) Notification, 2011 (S.O.19(E), dt. 06/01/2011)	<p>This notification under Environment (Protection) Act, 1986 supplements the law on site clearance by declaring certain zones as CRZ and regulates activities in these zones.</p> <ul style="list-style-type: none"> At Chengulam Odai diversion to Upparu river of length 207 m (From CH- 4526 to CH-4733) comes under CRZ-I area as per Coastal Zone Management Plan of Tamil Nadu for Thoothukudi district prepared by Department of Environment, GIS Cell, Government of Tamil Nadu. Area of chainage comes under CRZ

		requires CRZ clearance from TNSCZMA. Please refer FigNo. 4.1 for CRZ applicability
15	Plastic waste (Management & handling) Rules 2011	This rules provides guidelines for manufacturer of plastic bags with respect to thickness (40microns), labeling of plastic bags and prohibits availability to consumers free of cost. Further, these rules lay the responsibility of disposal of these wastes in scientific manner with the municipalities/urban local body. The provisions are applicable to TCMC.
16	Prohibition of Employment as Manual Scavengers' and their Rehabilitation Bill 2012	This act prohibits construction of insanitary latrines and employment or engaging of manual scavenger for the purpose of manual scavenging. The project is only stormwater drainage however, considering the spirit of the Bill, to avoid manual cleaning of the chambers and to facilitate maintenance by machineries, inspection doors are provided.
17	Regulations related to Labour Welfare	Provisions of various regulations like The Factories Act, 1948 and the Building and other Construction Workers (regulation of Employment and Conditions of Services) Act, 1996, etc are to be adhered to.
Operational Policies And Directives of The World Bank		
	OP/BP 4.01 - Environmental Assessment	Operational Policy 4.01 (OP 4.01) is one of the ten safeguard policies of the World Bank, which provides the Environmental Assessment (EA) guidance for the lending operations. The OP 4.01 requires the borrower to screen projects upstream in the project cycle for potential impacts. Thereafter, an appropriate EA approach to assess, minimize / enhance and mitigate potentially adverse impacts is selected depending on nature and scale of project. The EA needs to be integrated in the project development process such that timely measures can be applied to address identified impacts. The policy requires consultation with affected groups and NGOs to recognize community concerns and the need to address the same as part of EA. TNUIFSL has adopted the principles of the above policy and has evolved a management framework to address the environmental issues in its lending operations.

4.2 CRZ APPLICABILITY:

Fig.No. 4.1 Coastal Zone Management Plan of Tamil Nadu for Thoothukudi District



As per Coastal Zone Management Plan of Tamil Nadu for Thoothukudi district prepared by Department of Environment, GIS Cell, Government of Tamil Nadu area comes under CRZ is as follows

CRZ APPLICABILITY DURING PHASE-I

- **At Chengulam Odai diversion to Upparu river (SC-18A) of Length 207 m (From CH- 4526 to CH-4733) comes under CRZ-I area as per Coastal Zone Management Plan of Tamil Nadu for Thoothukudi district prepared by Department of Environment, GIS Cell, Government of Tamil Nadu.**

4.3 ENVIRONMENTAL PERMISSION REQUIRED

Clearances/permissions to be obtained for the project: Following Table shows the list of clearances/permissions required for project construction. This list is indicative and the TCMC and Contractor should ascertain the requirements, and obtain all necessary clearances/permissions prior to start of construction.

TABLE 4.3 CLEARANCES AND PERMISSIONS REQUIRED FOR CONSTRUCTION

Sr. No.	Construction Activity	Statutory authority	Statute under which Clearance is Required	Implementation	Supervision
1	Batch Mixing Plants for construction of new Storm Water Drains	Tamil Nadu Pollution Control Board (TNPCB)	Consent to establish and consent to operate under Water Act, 1974	Contractor and Project Implementation Unit (PIU)	PIU
2	Tree Cutting	Department of Forest and District Collector and TCMC.	Clearances from the Authorities as per the Tamil Nadu Timber Transit Rules, 1968 or latest.	PIU	Implementing agency and Project Management Unit (PMU)
3	Construction of drains in CRZ notified area	Tamil Nadu State Coastal Zone Management Authority (TNSCZMA)	Tamil Nadu State Coastal Zone Management Authority (TNSCZMA)	PIU	TCMC
4	Sand mining, quarries and borrow areas	Department of Geology and mining, GoTN	Contractor to obtain material from the existing government licensed mines / quarries; Contractor will require prior approval of PIU for obtaining material from a particular source. PIU to review and approve only existing licensed mines.	Contractor	PIU
5	Desilting, Disposal of excess silt and sand	District Collector and Department of Geology and Mining	Permission to be required from by TCMC prior to start of work. This is required for S.V.Kulam, Mullikulam & connecting channels.	PIU	TCMC
6	For establishing new quarries and borrow areas	MOEFCC	Not applicable No new quarries / borrow areas will be created for the sub-project.	Contractor	PIU
7	Disposal of bituminous wastes	Tamil Nadu State Pollution Control Board	Hazardous Wastes (Management and Handling) Rules. 1989	Contractor	PIU

8	Temporary traffic diversion measures	-	MoRTH 112 SP 55 of IRC codes	Contractor	PIU
9	Contractor Permits	-	Labour Permits/ Licences Contractors permit, Insurance, etc	Contractor	PIU

4.3.1 PROCESS FOR OBTAINING PERMISSION FOR TREE CUTTING:

- Before execution of the work permission from Revenue Divisional Officer (R.D.O.) is necessary. R.D.O is working under District collector.
- **Subsequently submit the tree cutting proposal by Commissioner of TCMC to RDO.**

4.3.2 PROCESS FOR OBTAINING CRZ CLEARANCE

- I. The project proponents shall apply with the following documents seeking prior clearance under CRZ notification to the Tamil Nadu State Coastal Zone Management Authority (TNSCZMA)-
 - Form-1 (Annexure-IV of the CRZ notification)
 - Rapid EIA Report including marine and terrestrial component except for construction projects listed under 4(c) and (d) of CRZ notification
 - Comprehensive EIA with cumulative studies for projects in the stretches classified as low and medium eroding by MoEF based on scientific studies and in consultation with the State Governments
 - Disaster Management Report, Risk Assessment Report and Management Plan;
 - CRZ map indicating HTL and LTL demarcated by one of the authorized agency (as indicated in para 2 of CRZ notification) in 1:4000 scale;
 - Project layout superimposed on the above indicated map;
 - The CRZ map normally covering 7km radius around the project site.
 - The CRZ map indicating the CRZ-I, II, III and IV areas including other notified ecologically sensitive areas;
 - No Objection Certificate from the Tamil Nadu Pollution Control Board for the projects involving discharge of effluents, solid wastes, sewage and the like.;
- II. The TNSCZMA shall examine the above documents in accordance with the approved CZMP and in compliance with CRZ notification and make recommendations within a period of sixty days from date of receipt of complete application,-
 - MoEF or State Environmental Impact Assessment Authority (SEIAA) as the case may be for the project attracting EIA notification, 2006;
 - MoEF for the projects not covered in the EIA notification, 2006 but attracting para 4(ii) of the CRZ notification;
- III. MoEF or SEIAA shall consider such projects for clearance based on the recommendations of the concerned CZMA within a period of sixty days.
- IV. The clearance accorded to the projects under the CRZ notification shall be valid for the period of five years from the date of issue of the clearance for commencement of construction and operation.

4.3.3 PROCESS FOR OBTAINING CONSENT FOR BATCH MIXING PLANT

- Fill the application in prescribed format of Tamil Nadu Pollution Control Board under section 25 of the Water (Prevention & Control of Pollution) Act, 1974 & under section 21 of the Air (Prevention & Control of Pollution) Act, 1981 for consent authorization.
- Attach mandatory documents mentioned in Application form.
- Submit the filled application with necessary documents in duplicate to TNPCB.
- Obtain consent to establish/operate from TNPCB.

CHAPTER 5 - BASELINE ENVIRONMENTAL STATUS

The study of environmental profile of the project was considered for 50 m both sides of the primary, secondary & tertiary drains.

Various environmental parameters such as Geology, Topography, Meteorology, Land use pattern, Soil characteristics, Water quality, Ambient air quality, Flora & Fauna, Socio economic condition, solid waste management were considered in baseline environmental profile of the project.

This data for the Project area is collected by the Consultant during the period March-April 2016 and thus is useful for the report upto March 2019.

5.1 GEOLOGY:

Gypsum associated with kankar has been reported from a few localities. Gypsum is a by-product in the salt pans, located along the east coast. Lime shell with 50-55 % CaO is known from the Coast at tracks of Thoothukudi.

Gypsum, limestone, beach sand, kankar and shell limestone are the economic minerals of the District. Rough stone, Jelly, Gravel, Clay, Earth & Granite are the minor minerals and leases are granted for quarrying of the said minerals in Thoothukudi.

Rock types found in the area belong to the Khondalite and Charnockite groups and Migmatite Complex of Easter Ghats Super group (Archaean Age), which are unconformably overlain by Tertiary and Quaternary sediments. Garnet-biotite-sillimanite gneiss, quartzite, calc-granulite and limestone of Khondalite Group with epidiorite, occurring as narrow linear bands. Charnockite Group is represented by acid variants. These rock types occur as xenoliths within the Migmatite Complex occupy a major part of the area, comprising medium grained hornblende-biotite gneiss and garnet-biotite gneiss. Grey and pink granite represent the last phase of granitic activity and occur as concordant intrusive bodies.

Quaternary sediments occur along the river valley and the East Coast. They are grouped into fluvial-marine, Aeolian and marine. Calcareous sandstone and siliceous limestone of Quaternary age unconformably overlies the Tertiary sediments marked by a conglomerate. The calcareous sandstone is interbedded with limestone. The rocks are coarse grained, poorly consolidated and friable with recent marine shells of which *Ostrea Sp.* is the most common. The rocks occur as massive beds of sheet tufa resulting from segregation of lime bleached out of the underlying garnet gneiss.

5.2 CLIMATE OF THE REGION:

The climate data of the Thoothukudi region includes minimum/maximum temperature, relative humidity and rainfall.

The city experiences tropical climatic conditions characterized with immensely hot summer, gentle winter and frequent rain showers. Summer extends between March & June when the climate is very humid. Thoothukudi registers the maximum temperature of 39⁰ C and the minimum temperature of 22.6⁰ C. The city receives adequate rainfall during the months of October & November. The city receives around 673 mm average rainfall during a year out of which 467 mm rainfall is in October to December from the

Northeast monsoon. The coolest month is January and the hottest months are from May to June. The city has a very high humidity being in the coastal sector.

Table 5.1 Climate data for Thoothukudi

Month	Avg. Max Temp ($^{\circ}\text{C}$)	Avg. Min Temp ($^{\circ}\text{C}$)	Avg. Rainfall (mm)
January	30.4	22.6	8
February	32.2	22.9	29
March	34.6	24.5	16
April	35.2	26.1	48
May	39.0	27.3	28
June	35.0	27.0	4
July	33.9	26.6	4
August	34.2	26.5	3
September	34.4	26.1	14
October	33.0	25.2	136
November	30.5	23.8	238
December	30.0	23.0	93

Fig. 5.1 Graphical representation of yearly avg. Temp in $^{\circ}\text{C}$

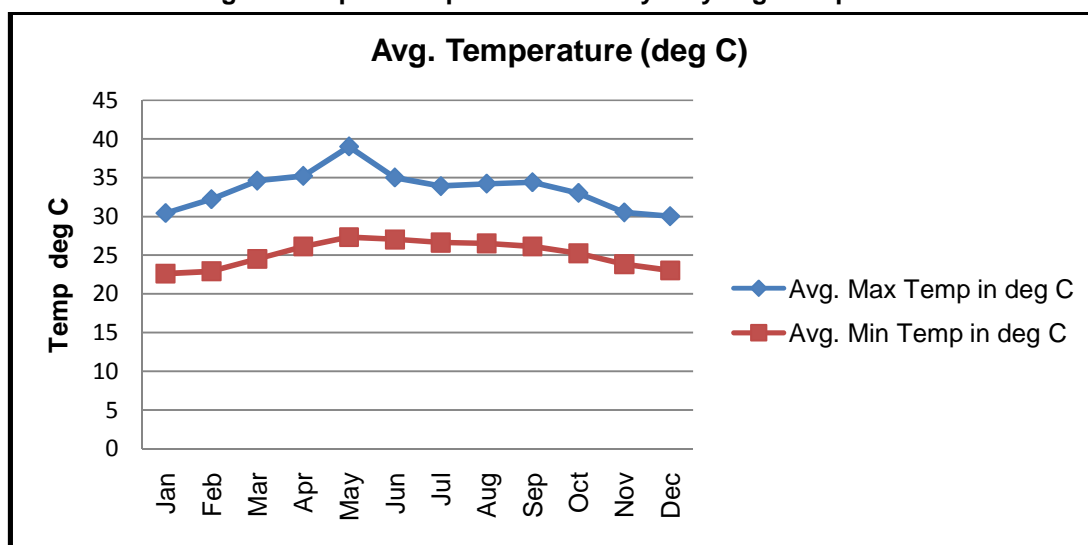
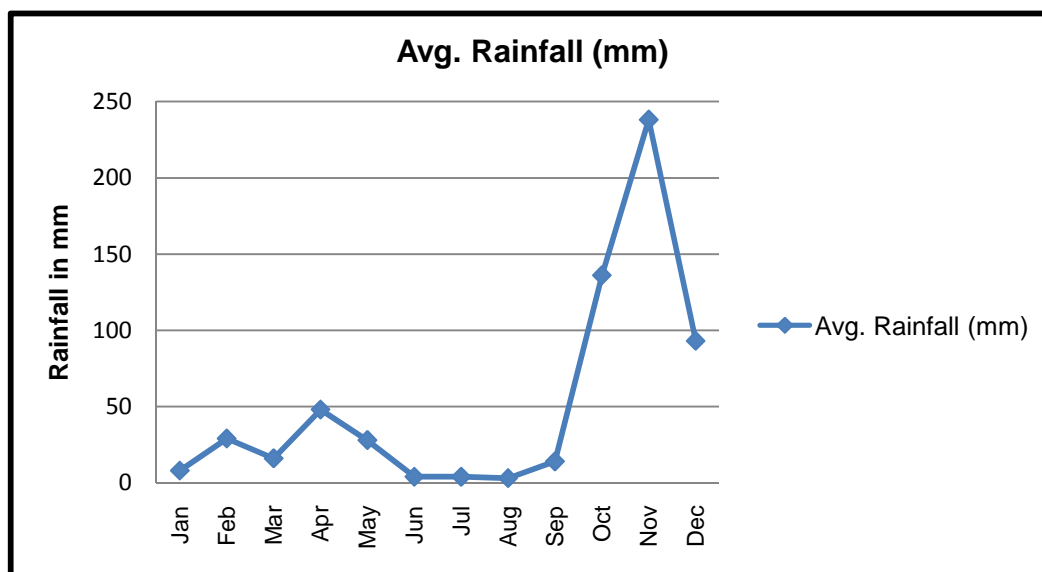


Fig. 5.2 Graphical representation of yearly avg. rainfall in mm



5.3 AMBIENT AIR ENVIRONMENT:

The ambient air quality monitoring data has been collected from Central Pollution Control Board (CPCB) website for Thoothukudi Corporation area. The average values obtained are presented in Table 5.2

Table 5.2 Ambient Air Quality for Selected Area of Thoothukudi Corporation

Location	Type of area	2016				PM ₁₀	PM _{2.5}
		SO ₂	NOx	NH ₃	CO		
Raja agencies	Industrial	7.13-17.41 µg/m ³	12.20-25.83 41 µg/m ³	0.00-22.60 41 µg/m ³	0.08-0.35 41 µg/m ³	37.01-80.80 41 µg/m ³	11.95-27.20 41 µg/m ³

Source- TNPCB Year book NA- Not Available

The Ambient Air Quality sampling locations of Thoothukudi corporation area comprise of Residential and Industrial Category. The residential category includes AVM buildings and Industrial Category includes,. The air quality monitoring results are interpreted as below:

All concentration of Pollutants are well within the available limits as per NAAQ standards.

5.4 AMBIENT NOISE ENVIRONMENT

The noise level survey conducted by the TNPCB reveals that noise level exceeded the limits mostly in commercial areas, mainly due to vehicular movement. During festive seasons in Thoothukudi, the noise levels were noted high and particularly during Deepavali it exceeded 100 dB.

5.5 WATER ENVIRONMENT

The baseline status of surface water quality along the storm water drain has been established through sampling and analysis of various water quality parameters as part of the environmental monitoring conducted by the Consultants. At ten locations water samples were collected and analyzed for various parameters.

Out of ten locations, five water samples were collected from ground water and remaining five were collected from surface water bodies.

The water quality monitoring was conducted by TWAD Board District Water Testing Laboratory at Manjalneerkayal, Thoothukudi.

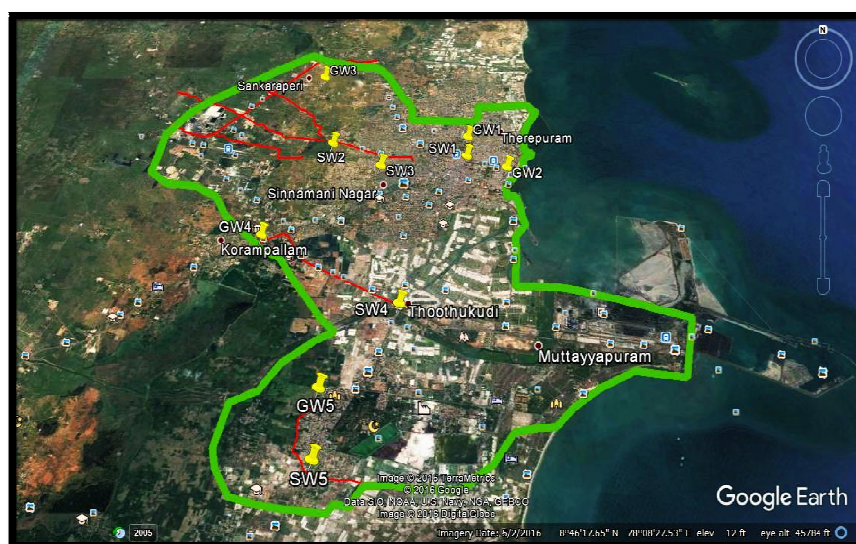
The sampling locations were selected based on existing land use and nature of water sensitive locations.

The details of surface & ground water sampling locations are presented in Table 5.5 Results of analysis are presented in Table 5.6 & 5.7 respectively. Water quality results were compared with BIS water quality standards.

Surface & ground water quality monitoring was conducted on 31.3.2016. The photographs of water sampling are presented in fig 5.4

Table 5.4 Surface & Ground water sampling location details along project drain

Location code	Date of sampling	Name of Location	Latitude, Longitude
Surface water sampling locations			
SW1	31.3.2016	SeenaVannaKulam	8°48'40.40" N 78°6'49.13" E
SW2	31.3.2016	UpparuOdai (Near Bridge)	8°45'46.21" N 78°7'56.03" E
SW3	31.3.2016	Buckle canal	8°48'12.26" N 78°7'34.6" E
SW4	31.3.2016	Near Shivam temple (Teppakulam)	8°48'24.47" N 78°8'52.72" E
SW5	31.3.2016	Mullakkadu canal (Near Tiruchendur road crossing)	8°43'43.20" N 78°7'1.57" E
Ground water sampling locations			
GW1	31.3.2016	South Zone at Sundaram nagar	8°44'35.21" N 78°7'75.00" E
GW2	31.3.2016	North Zone-well at American hospital junction	8°48'48.9" N 78°8'54.3" E
GW3	31.3.2016	East Zone-well at Sub collector office	8°48'9.97" N 78°9'28.51" E
GW4	31.3.2016	West Zone- well at Collector office side	8°46'53.26" N 78°5'58.59" E
GW5	31.3.2016	Sankaraperi village, Ganeshan nagar	8°50'13.9" N 78°6'32.8" E

Fig.5.3 Surface & Ground Water Sampling Location Map**Fig 5.4 Surface & Ground water sampling photographs**



Surface Water: Upparu Odai



Surface Water: Buckle Canal



Surface Water: Seena Vanna Kulam



Surface Water: Mullakkadu Canal



Surface Water: Shivam Temple Kulam



Ground Water: Well at Collector Office



Ground Water: North Zone-Well. American Hospital Junction.



Ground Water: Sankaraperi Village- Ganeshan Nagar



Ground Water: South Zone: Sundaram Nagar



Ground Water: East Zone. Sub-Collector Office-Well.

Table 5.5 Surface Water Quality Analysis Results

Sr No	Parameters	Unit	33126/ SW1	33128/ SW2	33130/ SW3	33132/ SW4	33134/ SW5	BIS 10500:2012	
								Acceptable limit	Permissible limit
1	Appearance	--	Slightly Greenish	Slightly Brownish	Greenish	Greenish	Brownish	--	--
2	Colour	Hazen	<15	<15	<15	<15	<15	5	15
3	Odour	--	Agreeable	H ₂ S smell	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4	pH	--	6.26	7.12	7.41	7.26	7.14	6.5-8.5	6.5-8.5
5	Turbidity	NTU	3.0	3.4	8.0	6.2	8.0	1	5
6	Electrical Conductivity	--	875	11180	3910	850	1970	--	--
7	Total Dissolved Solids	mg/l	570	7620	2620	570	1360	500	2000
8	Total Alkalinity as CaCO ₃	mg/l	24	154	562	238	505	200	600
9	Total Hardness as CaCO ₃	mg/l	214	2525	1010	194	545	200	600
10	Calcium as Ca	mg/l	56	672	268	52	146	75	200
11	Magnesium as Mg	mg/l	18	263	82	15	43	30	100
12	Sodium as Na	mg/l	86	1120	360	92	180	--	--
13	Potassium as K	mg/l	8	106	30	8	20	--	--
14	Iron as Fe	mg/l	0.05	0.5	0.05	BDL	0.05	0.3	0.3
15	Manganese as Mn	mg/l	BDL	0.1	BDL	BDL	BDL	0.1	0.3
16	Free Ammonia as NH ₃	mg/l	0.05	0.20	1.60	0.50	0.50	0.5	0.5
17	Nitrite as NO ₂	mg/l	2.0	0.24	0.60	0.32	0.36	--	--
18	Nitrate as NO ₃	mg/l	8	108	44	10	16	45	45
19	Chloride as Cl	mg/l	41	3117	892	122	265	250	1000
20	Fluoride as F	mg/l	1.20	0.20	0.20	0.20	0.20	1.0	1.5
21	Sulphate as SO ₄	mg/l	325	408	103	24	48	200	400
22	Phosphate as PO ₄	mg/l	0.20	0.20	0.50	0.20	0.20	--	--
23	Tidys Test 4 hrs as O ₂ mg/l	mg/l	0.52	0.64	0.80	0.76	0.76	>4	>4
24	Faecal coliform bacteria	No/100 ml	100	400	1200	300	500	Nil/100 ml	Nil/100 ml

BDL-Below Detection Limit

Table 5.6 Ground Water Quality Analysis Results

Sr No	Parameters	Unit	33118/ GW1	33120/ GW2	33122/ GW3	33124/ GW4	33136/ GW5	BIS 10500:2012	
								Acceptable limit	Permissible limit
1	Appearance	--	Clear	Clear	Clear	Slightly Greenish	Clear	--	--
2	Colour	Hazen	<15	<15	<15	<15	<15	5	15
3	Odour	--	Agreeable	Agreeable	Agreeable	Algae smell	Agreeable	Agreeable	Agreeable
4	pH	--	7.33	7.46	7.25	7.36	7.29	6.5-8.5	6.5-8.5
5	Turbidity	NTU	1.2	1.0	1.2	3.0	1.0	1	5
6	Electrical Conductivity	--	1840	990	1030	870	1785	--	--
7	Total Dissolved Solids	mg/l	1250	665	710	562	1215	500	2000
8	Total Alkalinity as CaCO ₃	mg/l	404	271	307	259	238	200	600
9	Total Hardness as CaCO ₃	mg/l	555	263	360	246	545	200	600
10	Calcium as Ca	mg/l	148	70	96	69	146	75	200
11	Magnesium as Mg	mg/l	44	21	29	21	43	30	100
12	Sodium as Na	mg/l	160	90	76	76	156	--	--
13	Potassium as K	mg/l	20	10	10	8	16	--	--
14	Iron as Fe	mg/l	BDL	BDL	BDL	BDL	BDL	0.3	0.3
15	Manganese as Mn	mg/l	BDL	BDL	BDL	BDL	BDL	0.1	0.3
16	Free Ammonia as NH ₃	mg/l	0.20	0.20	0.20	1.0	0.10	0.5	0.5
17	Nitrite as NO ₂	mg/l	0.18	0.16	0.16	4.0	0.18	--	--
18	Nitrate as NO ₃	mg/l	20	10	10	10	16	45	45
19	Chloride as Cl	mg/l	255	120	124	59	245	250	1000
20	Fluoride as F	mg/l	0.80	0.40	0.40	0.2	0.4	1.0	1.5
21	Sulphate as SO ₄	mg/l	122	48	28	62	250	200	400
22	Phosphate as PO ₄	mg/l	BDL	BDL	BDL	0.20	0.20	--	--
23	Tidys Test 4 hrs as O ₂ mg/l	mg/l	0.56	0.52	0.56	0.68	0.56	>4	>4
24	Faecal coliform bacteria	No/100 ml	Nil	Nil	Nil	Nil	Nil	Nil/100 ml	Nil/100 ml

BDL-Below Detection Limit

OBSERVATIONS-

pH-

The values of pH in the water samples collected from study area ranges from 6.26 to 7.41 for surface water and 7.25 to 7.46 for ground water. The observed values of pH are within permissible limits of BIS 10500.

TURBIDITY-

The values of Turbidity for ground water samples are within permissible limit which ranges from 1-3 NTU. For surface water samples Turbidity exceeds the permissible limits at location SW3, SW4 & SW5. At location SW1 & SW2 Turbidity is within permissible limit.

ELECTRICAL CONDUCTIVITY-

Table 5.7 Classification of water based on Electrical Conductivity

Electrical Conductivity	Classification	Ground water sample	Surface water sample
0-250	Low (Excellent quality)	0	0
251-750	Medium (Good quality)	0	0
751-2250	High (Permissible quality)	5- GW1, GW2, GW3, GW4, GW5	3-SW1, SW4, SW5
2251-6000	Very high	0	1-SW3
6001-10000	Extensively high	0	0
10001-20000	Brines weakly conc.	0	1-SW2
Total number of samples		5	5

From the above table it is conclude that none of the water sample having good quality. Ground water samples from locations GW1, GW2, GW3, GW4, GW5 and Surface water samples from location SW1, SW4, SW5 having high salinity & permissible quality. SW3 having very high water salinity & SW2 having brines weakly concentrated.

TOTAL DISSOLVED SOLIDS-

Table 5.8 Classification of water based on Total dissolved solids

Total dissolved solids (mg/l)	Classification	Ground water sample	Surface water sample
<500	Desirable for drinking	0	0
500-1000	Permissible for drinking	3- GW2, GW3, GW4	2- SW1, SW4
1000-3000	Useful for irrigation	2- GW1, GW5	2- SW3, SW5
>3000	Unfit for drinking & irrigation	0	1-SW2
Total number of samples		5	5

From the above table it is conclude that none of the water sample is desirable for drinking purpose. Ground water samples from locations GW2, GW3, GW4 and Surface water samples from location SW1, SW4 are permissible for drinking. Ground water samples from locations GW1, GW5 and Surface water samples from location SW3, SW5 are useful for irrigation. Surface water from SW2 is unfit for drinking & irrigation purpose.

TOTAL HARDNESS -

Table 5.9 Classification of water based on Total hardness

Total hardness as CaCO_3 (mg/l)	Classification	Ground water sample	Surface water sample
<75	Soft	0	0
75-150	Moderately hard	0	0
150-300	Hard	2- GW2, GW4	2- SW1, SW4
>300	Very hard	3- GW1, GW3, GW5	3- SW2, SW3, SW5
Total number of samples		5	5

From the above table it is conclude that none of the water sample is soft as well as moderately hard. Ground water samples from locations GW2, GW4 and Surface water samples from location SW1, SW4 are hard. Ground water samples from locations GW1, GW3, GW5 and Surface water samples from location SW2, SW3, SW5 are very hard.

TOTAL ALKALINITY AS CaCO_3 -

Total alkalinity for all Ground & Surface water samples is found within permissible limit which ranges from 238- 404 mg/l and 24- 562 mg/l respectively.

CALCIUM AS CA-

Calcium concentration is varying between 69-148 mg/l for Ground water & 52-672 mg/l for surface water samples. The permissible limit of calcium ion concentration is 200 mg/l. So surface water from location SW2 & SW3 are beyond the permissible limits.

MAGNESIUM AS MG-

Magnesium as Mg for Ground water samples at locations GW2, GW3, GW4 is below acceptable limit & at location GW1, GW5 is below permissible limit. For surface water samples at location SW2 concentration of Magnesium is above the permissible limit.

IRON AS FE-

Iron concentration is below detection limit for Ground water samples. For Surface water samples at location SW2 Iron is above permissible limit and at remaining locations it is below the acceptable limit.

MANGANESE AS MN-

Manganese concentration is below detection limit for Ground water samples. For Surface water samples at location SW2 concentration of Manganese is 0.1 mg/l and at remaining locations it is below detection limit.

FREE AMMONIA AS NH_3 -

For Surface & Ground water at locations SW3 & GW4 the concentration of ammonia is above the permissible limit and for remaining all locations it is below the permissible limit.

NITRATE AS NO_3 -

For Ground water samples at all locations Nitrate is below permissible limit.

For Surface water samples except the location SW2 it is below permissible limit.

CHLORIDE AS CL-Chloride is below permissible limit at all five locations for Ground water. For surface water it is above permissible limit at location SW2.

FLUORIDE AS F-

Fluoride concentration is within acceptable limit for all Ground & Surface water locations.

SULPHATE AS SO₄-

At location SW2 Sulphate concentration is above permissible limit. For remaining all Surface & Ground water locations it is below permissible limit.

FAECAL COLIFORM BACTERIA-

Faecal coliform is high in Surface water. Presence of coliform in all samples shows contamination of water in region.

From the above observations it is concluded that most of the parameters are above acceptable limit of BIS 10500:2012 standards. Hence water is not suitable for drinking purpose without conventional treatment followed by disinfection. **The TCMC shall regularly insure that required and adequate disinfectants will be administered in such wells. TCMC shall also take efforts to supply piped & treated water from existing water supply scheme to the localities where presently wells are used for domestic consumption purpose. This will ensure in public health improvement of persons using water from such ways.**

5.6 LAND ENVIRONMENT

Land use pattern map was collected from the Thoothukudi Local Planning Authority, Directorate of Town and Country Planning and digitized to find out the areas of different land use.

Thoothukudi City Municipal Corporation has been recently extended with merger of the adjacent 4 Panchayats and Thoothukudi Rural area. The present coverage of Thoothukudi Municipal Corporation is about 90.66 sq.km, out of which, old Thoothukudi Corporation area is only 13.47 Sq.km whereas and added adjacent 4 Panchayats and Thoothukudi Rural area is 77.19 Sq.km which is about 85% of total area of 90.66 Sq.km.

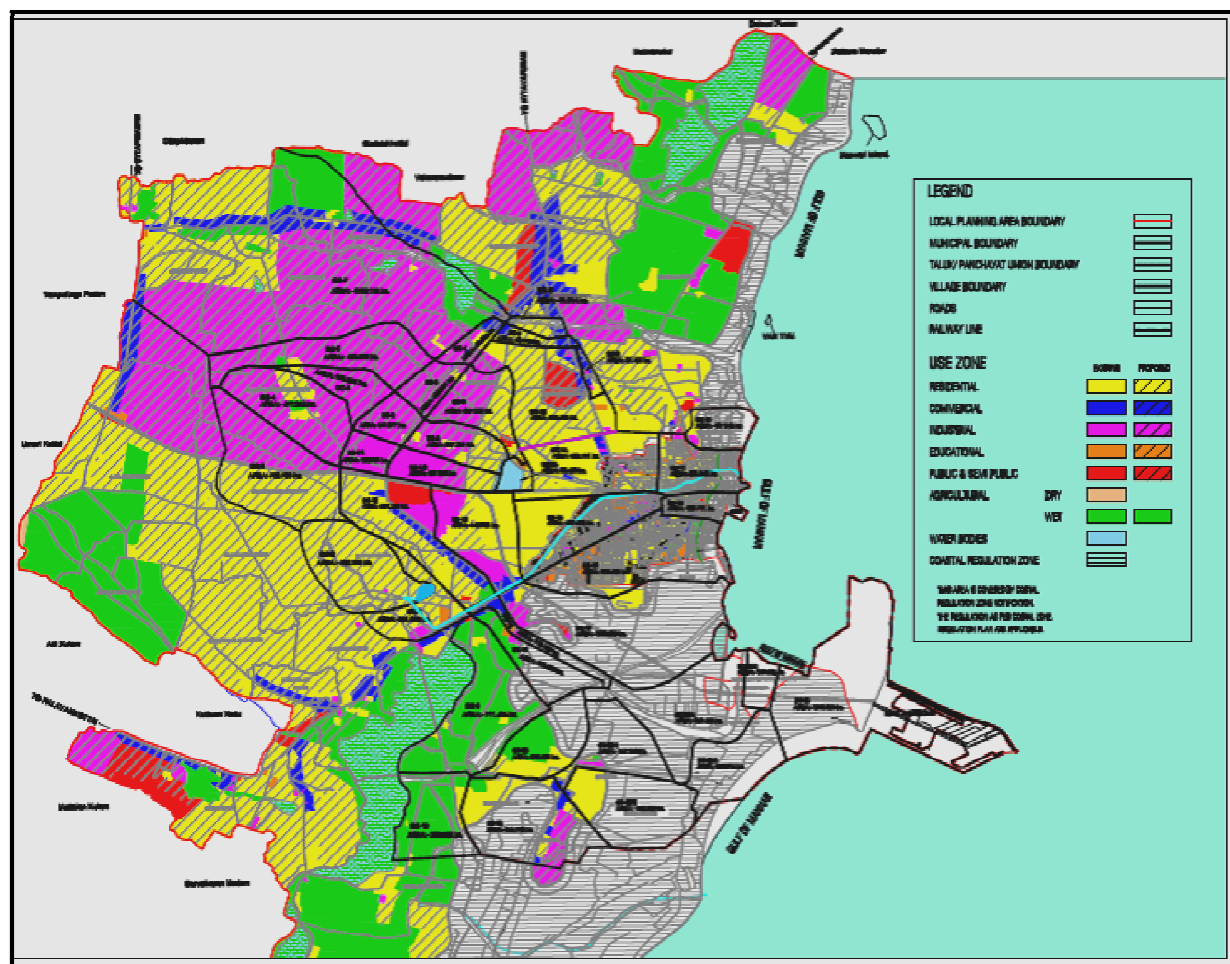
The old Land use pattern (1995) prevailing during the time of the Modified Master Plan is furnished in Table No 5.11 below.

Table No 5.10 Proposed land use pattern for Thoothukudi Corporation Area (Up to Year 2021)

Sr. No	Land Use	Area in hectare	Percentage of area
1	Residential	3274.21	30.12
2	Commercial	364.27	3.35
3	Industrial	1251.53	11.51
4	Institutional	75.05	0.69
5	Public & Semi Public	227.12	2.06
6	Roads	625.24	5.77
7	Agriculture	233.28	2.15
8	Water bodies	121.67	1.12
9	Coastal regulation	4699.09	43.23
	Total	10871.96	100%

The residential areas covers 30.12 % and costal regulation area is maximum i.e. 43.23 %. In future, the open areas may get converted into residential areas due to rapid urbanization and other infrastructure developments.

Fig 5.5 Land Use Plan (Valid upto 2021)



5.7 SOIL QUALITY

Thoothukudi being in coastal region, the soil is mostly clay sandy and the water table varies between 1 and 4 m below ground level. The city has loose soil with thorny shrubs in the north side and salt pans in the south.

A red soil found on the southern side of the Thoothukudi town is composed of quartz and variable quantities of fine red dry dust. The bay formed by the Hare Island, Devils point and the main land gives ample protection to the lighters from monsoon weather.

The types of soil and the area listed in Table 5.12

Table 5.11 Common Soil types with location in Thoothukudi district

Sr No	Type of Soil	Location
1	Red loam	Udangudi, Kayatar, Sattankulam
2	Laterite	Srivaikundam, Tiruchendur
3	Black	Kovilpatti, Kayatar, Vilathikulam, Thoothukudi, Ottapidaram
4	Sandy Coastalalluvium	Tiruchendur
5	Red sandy	Udangudi, Sattankulam, Srivaikulam, Karungulam, Ottapidaram, Vembar.

5.8 SILT QUALITY

The project drains consists of all types of wastes, hence a silt quality monitoring was conducted to know the physical, chemical and biological composition of the silt material. The silt monitoring was done by Sheetal Analytical Laboratory, Pune on 15.4.2016. Silt quality monitoring will help in identifying the suitable methodology for safe disposal of the silt material, hence silt quality monitoring was conducted at three locations. Silt quality analysis results are given in below table no. 5.12

Table 5.12 Silt Quality Analysis Results

Sr. No.	Parameters	Unit	Silt Sample-1	Silt Sample-2	Silt Sample-3	Test Method
1	pH	-	7.24	7.11	6.81	IS 2720 (Part 26):1987
2	Moisture Content	%	57.65	48.19	54.52	IS 2720: Part 2
3	Electrical Conductivity	mS/cm	3.18	0.556	0.639	EPA method 9045
4	Bulk Density	g/cc	1.407	2.07	1.489	ASTM D7263
5	Colour	-	Grey	Light Brown	Grey	Visual method
6	Water Holding Capacity	mm/cm	0.07			USDA:1954-Reaffirmed 2010, Page 39
7	Total Organic Carbon		4.086	6.43	3.59	
8	Organic Carbon	%	9.73	15.33	8.46	Walkey & Black method
9	Inorganic Residues	%	90.27	84.67	91.54	IS:10158:1982 (Reaff: 2009)
10	Available Nitrogen	mg/kg	0.1295	0.1145	0.1312	Kjeldhal method
11	Available Phosphorous	mg/kg	0.0621	605.7	0.190	Olsen method
12	Available Potassium	mg/kg	0.97	0.198	1.01	EPA 3050 B
13	Exchangeable Sodium as Na	m.eq/100g	1420	672.29	950.92	FAO Chapter 3/SOP 6
14	Iron as Fe	mg/kg	2.42	0.861	2.24	EPA 3050 B

15	Copper as Cu	mg/kg	122.85	173	494.8	EPA 3050 B
16	Manganese as Mn	mg/kg	930.37	222.96	459.67	EPA 3050 B
17	Zinc as Zn	mg/kg	597.16	37.02	58.70	EPA 3050 B
18	Cadmium as Cd	mg/kg	0.234	0.64	1.93	EPA 3050 B
19	Chromium as Cr	mg/kg	41.58	7.10	3.063	EPA 3050 B
20	Lead as Pb	mg/kg	31.04	6.06	13.06	EPA 3050 B
21	Nickel as Ni	mg/kg	133.05	22.14	66.35	EPA 3050 B
22	Chloride as Cl	mg/kg	165.10	51	48.27	EPA 3050 B
23	Total Coliform	CFU/g	3×10^4	2×10^2	6×10^4	EPA 1680
24	Faecal Coliform	CFU/g	8×10^2	48	9×10^2	EPA 1680

Silt Sample-1 Upparu River

Silt Sample-2 Buckle Canal

Silt Sample-3 Seena Vanna Kulam

All the Silt parameters are falling within the concentration limits of compost in SWM Rules, 2016 and Hazardous waste (management & handling) Rule, 1989 and its amendments. Total & Faecal Coliforms were present in all the silt material monitored in all drains, which should be thoroughly dried before disposing off.

5.9 BIOLOGICAL ENVIRONMENT

Natural flora and fauna are important features of the environment. They are organized into natural communities with mutual dependencies among their members and show various responses and sensitivities to physical innocence.

Biodiversity of the project area includes the flora and fauna studies within the study zone. The investigation included field observations, discussions with local people, forest officials etc.

5.9.1 FLORA

The forest type available here in the sanctuary area is 6A/DSI that is Southern Thorn Shrub. The species composition as furnished below is mostly of thorny hardwood and xerophytes. *Dalbergialatifolia*, *Dichrostachys cinerea*, *Acacia latronum*, *Acacia pennata*, *Albiziaamara*, *Zizyphus oenoplia* Species and a few *Azadirachtaindica*, *Dillenia pentagyna*, *Calotropis gigantean*, *Pongamia pinnata*, *Euphorbia nivilia*, *Acalyphafruticosa*, *Ocimum sanctum*, species form the under growth.

5.9.2 FAUNA -

Painted stork, Black vulture, Gidh, Spotted dove, Ring dove, Koel, Hornbill, Owl, Kingfisher are the commonly found birds in Thoothukudi.

Proposed project improvement does not offer any impact on fauna except for small mammals, such as mice and squirrels. Avifauna, such as crow, eagle, parrot, chicken etc, may reside or perch in the trees present along the project drains. Other than this, domestic animals such as cow, buffalo, goat, dogs, cats etc., are found in the project region. **No aquatic life/fauna is observed in the ponds included in this work as there is no significant water stored at present due to silting.**

CHAPTER 6 - ASSESSMENT OF IMPACTS

6.1 IDENTIFICATION OF POSSIBLE IMPACTS ON ENVIRONMENT

The proposed project is intended for better management of the hydrological situation and management of storm water, improvement of drainage and to prevent flooding in the low lying areas of the project area. However, the developmental activities which may be considered under the project both during under construction and operational phases may have some temporary or negligible impacts on various components of the environment. The baseline situation and the proposed activities have been analyzed for identifying the impacts from the project implementation.

Table 6.1 Possible Impacts on Environment

Project Activities	Components of Environment										
	Land	Air	Noise	Surface Water	Ground Water	Flora	Fauna	Resettlement & Land acquisition	Health & Safety	Road & Traffic issues	Any damage to Public & sensitive property
Clearing & Cutting	√	√	√	x	x	√	x	x	√	√	x
Excavation & Filling	√	√	√	√	x	x	x	x	√	√	x
Disposal of Excavated Silt	√	x	x	√	x	√	x	x	x	√	x
Drain Construction	√	√	√	x	x	√	x	x	√	√	x
Construction Camps	√	x	x	√	x	x	x	x	√	x	x
Disposal of Storm Water	√	x	x	√	x	x	x	x	√	√	x

6.2 POTENTIAL NEGATIVE IMPACTS

Phase wise potential negative impacts arising due to proposed project activity are summarized below.

Table 6.2 Potential Adverse/Negative Impacts

Phase wise project activities	Potential Negative Impacts
During Construction Phase	
Clearing and Cutting	<ul style="list-style-type: none"> • Loss of top soilVegetation loss due to cutting of small shrubs and trees • Increase of respirable suspended particulate matters & dust insurrounding ambient air • Noise & vibration disturbances of fauna and local population during cutting of tress • During clearing and cutting, there may be some hindrance in traffic due temporary increased machinery traffic • There may be little impacts on health's due to Increase of respirable suspended particulate matters and noise level
Excavation & Filling Operations	<ul style="list-style-type: none"> • Loss of top soil • Increase of respirable suspended particulate matters & dust insurrounding ambient air • Noise & vibration disturbances of fauna and local population duringcutting of trees • Spillage of oil and other substances during the civil works • During excavation, there may be some hindrance in traffic duetemporary increased machinery traffic • There may be little impacts on health's due to Increase of respirablesuspended particulate matters
Disposal of Excavated silt	<ul style="list-style-type: none"> • Soil and water contamination due to improper disposal of excavatedmaterial, construction and demolition wastes • Clogging of drains due to improper disposal of excavated material,construction and demolition wastes • Water laden silt/clay/materials with faecal coliforms (see note aboe) fromdrains to ve treated properly. To be stored in containment; carried to predetermined & secured area in covered vehicles from which it wont drip on to roads etc etc.. • Loss of vegetation at dumping yard
Construction of labor Camps	<ul style="list-style-type: none"> • Impacts on surrounding due to improper drainage, sanitation facilities,solid waste management facilities during the use of temporaryconstruction sites (camps, machinery sites, storage facilities etc.)
During Operational Phase	
Disposal of Stormwater	<ul style="list-style-type: none"> • Contamination of storm water due to mixing of sewage or

	<p>industrialwastewater</p> <ul style="list-style-type: none">• Clogging of drains due to deposition of eroded soil, improper cleaning• Formation of misquotes breeding grounds• Foul smell• Accumulation of silt and its disposal
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6.3 POTENTIAL NEGATIVE IMPACT DUE TO CLEAR & CUTTING TREES

Trees can be harmed by construction work in several ways. Any break or tear in a tree's bark disrupts the flow of vital fluids and exposes wood to invasion by disease and decay microorganisms, which the tree must then expend energy to deal with. A trunk wound does not always cause corresponding loss of branches or foliage, so the consequences may not be fully apparent. But a large wound in the trunk of a tree is serious—it cannot be repaired and will almost certainly result in future decay and loss of stem strength.

Table- 6.3 Details of Trees to be cut during Phase-I

Sr. No	Name of Drain	Chainage		Name of Tree (Hindi name)	Botanical name	Tamil name	Girth (m)
		From	To				
1	NH-45B (E-F-G-H)	185	315	3 Gulmohor	<i>Delonix regia</i>	Mayil- konnai	1.0
		185	315	15 Gulmohor	<i>Delonix regia</i>	Mayil- konnai	0.8
		185	315	14 Gulmohor	<i>Delonix regia</i>	Mayil- konnai	0.4
		185	315	9 Gulmohor	<i>Delonix regia</i>	Mayil- konnai	0.2
		185	315	18 Neem	<i>Azadirachta indica</i>	Veppam	0.4
		185	315	2 Neem	<i>Azadirachta indica</i>	Veppam	0.2
		185	315	1 Pipal	<i>Ficus religiosa</i>	Arasu	0.4
Total				62			
2	Periapallam Odai (H to H1)	No Trees					
3	Kalangkari Odai (E1 to E)	No Trees					
4	Kalugupathai Odai (F1 to F)	No Trees					
5	Kaluthapathai Odai (G1 to G)	No Trees					
6	Kalugupathai Odai (F to F2)	1700	1800	1 Neem	<i>Azadirachta indica</i>	Veppam	0.80
		2300	2400	1 Chinch	<i>Tamarindus indica</i>	Puli	0.90
Total				2			
7	Kalangkari Odai (E2 to E3)	No Trees					
8	Kaluthapathai Odai (G to G2)	1300	1310	Neem	<i>Azadirachta indica</i>	Veppam	1.00
		1600	1700	Neem	<i>Azadirachta indica</i>	Veppam	0.80
		1800	1900	Tad	<i>Borassus flabellifer</i>	Palmyrah palm, Tadi	0.60

		1800	1900	Tad	<i>Borassus flabellifer</i>	Palmyrah palm, Tadi	0.60
		1800	1900	Tad	<i>Borassus flabellifer</i>	Palmyrah palm, Tadi	0.60
		1800	1900	Tad	<i>Borassus flabellifer</i>	Palmyrah palm, Tadi	0.60
		1800	1900	Tad	<i>Borassus flabellifer</i>	Palmyrah palm, Tadi	0.60
		2100	2200	Neem	<i>Azadirachta indica</i>	Veppam	0.50
		2100	2200	Neem	<i>Azadirachta indica</i>	Veppam	0.50
		2100	2200	Neem	<i>Azadirachta indica</i>	Veppam	0.50
		2100	2200	Neem	<i>Azadirachta indica</i>	Veppam	0.50
		2100	2200	Neem	<i>Azadirachta indica</i>	Veppam	0.50
		2200	2300	Neem	<i>Azadirachta indica</i>	Veppam	0.50
Total				13			
9	NH-7A/NH-45 B (JKC)	0	100	Tad	<i>Borassus flabellifer</i>	Palmyrah palm, Tadi	0.90
		1000	1100	Pipal	<i>Ficus religiosa</i>	Arasu	2.30
		1000	1100	Neem	<i>Azadirachta indica</i>	Veppam	1.00
		1000	1100	Neem	<i>Azadirachta indica</i>	Veppam	1.00
		1000	1100	Neem	<i>Azadirachta indica</i>	Veppam	1.00
		1000	1100	Neem	<i>Azadirachta indica</i>	Veppam	1.00
		1800	1900	Pipal	<i>Ficus religiosa</i>	Arasu	1.40
		3000	3100	Badam	<i>Terminalia catappa</i>	Nattu-vadam	0.80
		3900	4000	Neem	<i>Azadirachta indica</i>	Veppam	0.90
		3900	4000	Neem	<i>Azadirachta indica</i>	Veppam	0.90
Total				10			
10	Mullakadu Odai (S-T)	0	100	4 Neem	<i>Azadirachta indica</i>	Veppam	0.80
		0	100	2.Coconut	<i>Cocos nucifera</i>	Thennai	0.60
		0	100	2 Tad	<i>Borassus flabellifer</i>	Palmyrah palm, Tadi	0.60
		100	200	3 Neem	<i>Azadirachta indica</i>	Veppam	0.80
		100	200	1 Coconut	<i>Cocos nucifera</i>	Thennai	0.60
		100	200	1 Tad	<i>Borassus flabellifer</i>	Palmyrah palm, Tadi	0.60
		200	300	2 Neem	<i>Azadirachta indica</i>	Veppam	1.00
		200	300	6 Tad	<i>Borassus flabellifer</i>	Palmyrah palm, Tadi	1.00
		300	400	4 Neem	<i>Azadirachta indica</i>	Veppam	0.80

		300	400	3 Teak	<i>Tectona grandis</i>	Thekku	0.90
		300	400	2 Coconut	<i>Cocos nucifera</i>	Thennai	0.80
		300	400	3 Tad	<i>Borassus flabellifer</i>	Palmyrah palm, Tadi	0.90
		400	500	11 Tad	<i>Borassus flabellifer</i>	Palmyrah palm, Tadi	1.20
		500	600	15 Tad	<i>Borassus flabellifer</i>	Palmyrah palm, Tadi	1.00
		500	600	2 Neem	<i>Azadirachta indica</i>	Veppam	0.80
		600	700	1 Neem	<i>Azadirachta indica</i>	Veppam	1.20
		600	700	2 Tad	<i>Borassus flabellifer</i>	Palmyrah palm, Tadi	1.00
		1850	1900	Neem	<i>Azadirachta indica</i>	Veppam	1.30
		1900	1950	2 Neem	<i>Azadirachta indica</i>	Veppam	1.50
		2000	2100	5 Neem	<i>Azadirachta indica</i>	Veppam	1.80
		2300	2400	2 Karanj	<i>Pongamia pinnata</i>	Pongam	0.90
		2300	2400	5 Neem	<i>Azadirachta indica</i>	Veppam	1.00
		2300	2400	1 Pipal	<i>Ficus religiosa</i>	Arasu	1.30
Total				80			
11	Meelavittan Road	0	100	Neem	<i>Azadirachta indica</i>	Veppam	1.80
		0	100	Neem	<i>Azadirachta indica</i>	Veppam	1.50
		500	600	Karanj	<i>Pongamia pinnata</i>	Pongam	0.60
		600	700	Chinch	<i>Tamarindus indica</i>	Puli	1.50
		1000	1100	Neem	<i>Azadirachta indica</i>	Veppam	0.40
		1200	1300	Neem	<i>Azadirachta indica</i>	Veppam	0.60
		1300	1400	Neem	<i>Azadirachta indica</i>	Veppam	0.80
		1800	1900	Neem	<i>Azadirachta indica</i>	Veppam	0.80
		1900	2000	Neem	<i>Azadirachta indica</i>	Veppam	0.80
		1900	2000	Neem	<i>Azadirachta indica</i>	Veppam	0.80
Total				10			
Grand-Total				177			

6.4 DOWNSTREAM IMPACT ON STREAM

Channel wise downstream impacts are summarized in below given table

Table 6.7 Downstream impacts on stream

S. N.	Name of Drain / Proposal	Downstream impact on stream
A	North side Channels (Peria Pallam Catchment)	
1	Kalangkari Odai Upto NH-45B (E1-E)	The flow of the Periapallam Odai meets the creek and to then to the sea hence no adverse effect to downstream sides.
2	Kalagupathai Odai Upto NH-45B (F1-F)	
3	Kaluthupathai Odai Upto NH-45B (G1-G)	
4	Along NH-45B from Kalangakari Odai to Periapallam Odai (E-F-G-H)	
5	PeriaPallam Odai from bridge on NH-45B to bridge on Ramnathpuram (H-H1)	
B	Channels for S. V. Kulam Catchment	
6	Kalangakari Odai from NH- 45B to S.V. Kulam (E2-E3)	The flow from three Odai's meets to the S. V. Kulam hence no adverse downstream effect.
7	Kalagupathai Odai from NH-45B to S.V. Kulam (F-F2)	
8	Kaluthapathai Odai from NH-45B to S.V Kulam	
C	Channels for Upparu and Mullakkadu Catchment	
9	Chengulam Odai diversionto Upparu River (J2KC) (Initial 793m along NH-7A further 3840 along NH-7A and end portion of 100m parallel to SH	Upparu River directly meets the sea within Thoothukudi city limits only and hence no adverse downstream effect.
10	Mullakkadu Odai (S-T)	The Odai meets to the creek which meets the sea and hence no adverse downstream effect
D	Channels for Buckle Canal Catchment	
11	Drain Along Meelavettan Road from S.V. Kulam to Buckle Canal	The flow meets the Buckle canal which directly meets the sea. Hence no adverse downstream effect.
12	Drain along Railway line from S.V. kulam to Buckle Canal	

6.5 OTHER IMPACTS

Other impacts that may arise from the implementation of SWD are-

- i) Traffic issues due to excavation and construction activity
- ii) Safety issues due to excavation
- iii) Access difficulty to adjacent land use
- iv) Reverse flow into the drains from the canals
- v) Solid waste dumping in the drains
- vi) Disposal of excavated earth / silt
- vii) Social impact due to activities in the canals.

CHAPTER 7 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

To mitigate the identified impacts an Environmental Management Plan and Environmental Management Cost has been prepared.

The likely adverse impacts on various environmental components, viz., Land, Air, Water, Biodiversity and Social & Aesthetic have been assessed. Based on the identified impacts potential, the management practice to be followed for minimizing and mitigating the impacts on the surround environment, the activity wise Environment Management Plan is drawn. In summary, the expected impacts are of small scale, temporary and site specific depending on the implementation of the project and will not exceed the construction and major environmental norms. The EMP will be form part of the contract document.

7.1 MANAGEMENT MEASURES PROPOSED IN SWD TO SELECTED AREAS

7.1.1 GROUNDWATER RECHARGE THROUGH RAINWATER HARVESTING:

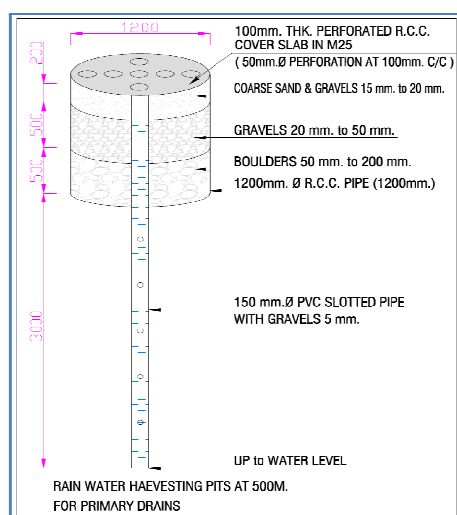
Rain water harvesting arrangements are proposed to be installed in primary drain.

Table 7.1 RWH pit details Phase-I

Phases	RWH pit No.	Diameter (mm)	Depth (m)
Phase-I	89	150	3

In Phase-I 89 No. RWH pits will be constructed. The rain water harvesting is proposed at 500m distance and it comprises of 150mm dia. bore of about 3.0m depth fitted with PVC slotted pipe and fixing of 1200mm dia. RCC pipe at its upper end just below the ground level. The RCC pipe is proposed to be fitted with filter media to exclude the silt entering into the water table.

Fig 7.1 Rain water Harvesting Pit Section



7.1.2 SEDIMENT CONTROL

For control of sediments it is proposed to construct Silt pits only in newly constructed tertiary drains and will be in the form of depression of about 45 to 60 cm for about 1.50 m length in those channels so that the sediments are deposited in the silt pits and settle over there which can be removed periodically.

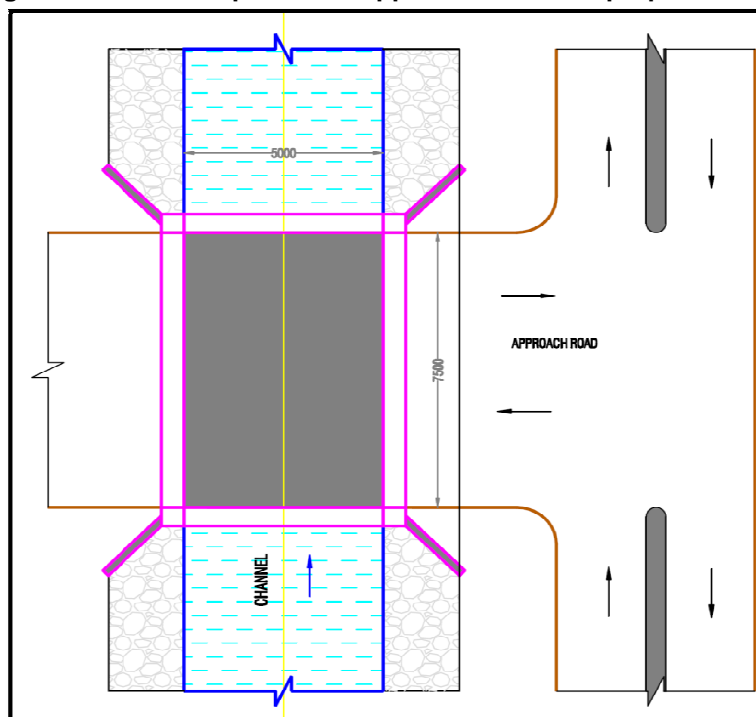
7.1.3 SOLID WASTE MANAGEMENT

At present Corporation of Thoothukudi is having an effective solid waste management system.. However, the people living nearer to water bodies and the commercial pockets situated near Water bodies have tendency to throw solid waste into water bodies.

Therefore the following practices are proposed in the SWD to TCMC.

- Micro drains are designed as box type drain in RCC with cover on top which will curtail dumping of solid waste in drains.
- Major micro drains belonging to Corporation of Thoothukudi will be provided with top cover in MS frame with wire mesh to avoid dumping solid waste.
- Rain water will flow into drains through FRP gratings provided to screen the solid waste from entering into drains.
- Public awareness programs have been proposed to proper waste disposal to ensure public co-operation.

Fig 7.2 RCC Box Proposed for Approaches across proposed drains



7.1.4 Access Difficulty

It has been proposed to provide access ramp at critical locations to facilitate easy movement of vehicles and provision has been made in the estimates for providing temporary access to the adjacent land uses.

7.1.5 PUBLIC AWARENESS

Public play a major role in the successful functioning of proposed stormwater drain. Periodical awareness programs have been proposed to deal with the various aspects that are to be considered to improve the local public awareness by involving individually or with the voluntary organization groups.

7.1.6 FLOOD MANAGEMENT

For flood management and to get relief from flood, effective measures will be undertaken in phase- I. Measures for effective flood management of the study area are as follows-

- Diversion of outside catchment flow from Kalangakari Odai, Kalugupathai Odai & Kaluthapathai Odai (On the north-west side of the city) along NH-45B to Periapallam Odai Upto Sea. By this proposal reduction of 1560 ha. Catchment area of Buckle canal will be achieved.
- Diversion of flow of Kalangakari Odai between portion from NH-45B and Meelavittan village to S.V. Kulam and the capacity of S.V. Kulam will also be improved.
- Diversion of flow of Kaluthapathai Odai (between portion NH-45B after the crossing of highway & Pandarmpatti) to S.V. Kulam.
- Improvements to S.V. Kulam by increasing the holding capacity, improvements to the bunds and diversion of flow to Buckle canal through Meelavittan road by constructing a new surplus weir in S.V. Kulam.
- Diversion of flow from Chengulam Odai to Upparu River along NH-45B. This proposal will reduce 2100 Ha catchment area of Buckle Canal.

By undertaking the above works it is expected that major flooding in the city will be avoided/ reduced for 5 year flood frequency and out of total 146 observed flood points the number of points as shown below can be partially or fully get relief for 5 year flood frequency.

TABLE- 7.2 FLOOD POINTS GETTING REDUCED PARTIALLY OR FULLY DUE TO PROPOSED PROJECT

Area	Total Flood Points as per Year 2015 observations	No. of Points getting partial or full relief
Downstream area of S.V. Kulam upto Ettayapuram Road	25	19
Chengulam odai to Upparu River	14	8
Buckle canal part portion from port railway line to Main railway line	14	7
Mullakadu Odai watershed and surrounding area	30	22
Total	83	56

Thus the partial/ full relief percentage for points located in the above 4 areas is about 67 % whereas the percentage as compared to the entire flood points of 146 number works out to 38%. With small part out of total cost investment the probable relief will be quite good and hence the Phase I work is proposed to be undertaken on priority.

7.1.7 DISPOSAL OF EXCAVATED EARTH/ SILT

It is envisaged that large quantity of silt would have to be disposed from the drains, canals & Seena Venna Kulam Lake.

Silt quantification-

Total Excavated quantity: 5,53,200Cum.

The excess excavated earth will be conveyed to the existing dumping yard at Tharuvaikulam located about 15Kms from SV Kulam. Necessary provision for conveyance of surplus earth has been made in the cost estimate. The vehicles conveying earth will be instructed to be covered with to avoid spreading of respirable suspended particulate matter & dust in the ambient air. Also, shall not drip the water from the silt while transporting. Should be transported each day without storing on site for more than a day. When stored on site it should not create harm / safety issues of any sort to people / traffic; storage area shall be well marked / contained. To be well contained and managed at disposal site too

7.1.8 TRAFFIC MANAGEMENT MEASURES

7.1.8.1 TRAFFIC DIVERSION

During the construction stage of storm water drain, traffic diversion or management may be required in any of the following conditions.

- i) If density of traffic is more in the construction road
- ii) Laying of storm water drain in major roads
- iii) If road width is lesser for traffic due to width of drains especially for arterial drains
- iv) Criticality of junction when drain crosses a junction
- v) Local significance and proximity to sensitive receptors / landuses like schools/hospitals. If these are nearby, drain construction plus traffic should not create havoc/safety issues. Should have constant watch and ward near sensitive receptors

7.1.8.2 PLANNING THE WORKS

The complexity of traffic diversion or management differs from scheme to scheme but the main objective is to maximize the safety of work force, public living nearby and the travelling public and the second objective is to keep traffic flowing as freely as possible. So the traffic management should be a safe system of work for both operatives and road users.

During the planning stage of works the following points should be noted.

- Intimation to the public living or shops available adjoining the construction site.
- Attention must be paid to the needs of pedestrians. This applies especially in the vicinity of bus stops, shops, where larger numbers of people with physical/mental impairments may be expected.
- Construction works should be undertaken in the minimum time, taking up the minimum of road space, but without compromising safety. Where practicable, additional resources or time-reducing techniques should be considered.
- There must always be liaison with the Authority concerned to avoid concurrent works in close proximity.

- Period of execution based on the area specific. For example if an educational institution is present the works may be planned during holidays.
- Transport authorities to be informed to plan their stops and routes if diverted
- There should be always liaison with traffic police and other emergency services

7.1.8.3 DESIGNING TRAFFIC MANAGEMENT

- a) Before execution minimum lateral (sideways) clearance should be given between moving traffic and work space

Outer boundary of work space especially ditches, bent bars should be provided with barricading

- b) Barricading should be visible in day and night and also adjacent to running traffic lane should be lined with traffic cones.
- c) Adequate working space should be provided around the work place to allow temporary works
- d) If density of traffic is more in construction road and the road is two way at least 5.5 m width should be maintained. If not possible a single way traffic may be enrooted on other possible way by providing proper indication on the entrance of road or before the diversion way. For oneway traffic at least 3.3 m clearance should be given for heavy vehicle or public transport. Only Car traffic may be maintained with 2.5 m width. Adequate warnings of narrow lanes must be given with proper signboard.
- e) For construction of drains in the major roads the points discussed above is applicable along with the sign to vehicles to restrict the speed within 30kmph while crossing construction site and sign indicating "no overtaking" may be erected during working hours.
- f) If road width is less than required i.e., at least 2.5 m for one way traffic during the period of construction, the road can be closed and traffic diverted along a suitable diversion road after according concurrence with traffic police and road authorities.
- g) For crossing of drains through culverts in major roads, push through technology is suggested. But if the culvert crosses through open excavation proper closing of traffic is required for crossing road.
- h) Proper diversion board indicating the "Road ahead is closed" the nature of work going ahead with authority name should be placed before the entrance of road with advance warning of diversion should be placed before 100m of diversion with arrow sign for diversion before 3m from the diversion road.
- i) A proper vehicle restraint and pedestrian barrier with proper signage board should be placed on either side of culvert crossing. All signages, contact numbers for emergency contact – of authorities, ambulance etc. First aid, toilets, water facilities, OHS for workers to work on heavy traffic roadsides.
- j)

7.1.9 TREE CUTTING AND COMPENSATORY PLANTATION:

Tree Cutting:

- i. The presence of trees adjacent to the drains/ canals and the vulnerable trees from the drain construction activity during phase- I are estimated as 177 No.
- ii. Adequate precaution shall be taken during implementation to keep the tree cutting at minimum.

- iii. However, when tree cutting is unavoidable, note with necessary details on the project and trees & photos and justification for tree cutting shall be submitted by the SWD Department to the competent authority and permission be obtained.
- iv. Tree cutting shall be carried out by the TCMC prior to start of work.

Compensatory plantation: The flora species shown included in para 5.9.1 are observed as a part of study of biological environment of the project area. List of trees which will be planted in lieu of tree cutting as compensatory tree plantation are shown in Table No: 7.4. Suggested those trees are native trees observed in surrounding areas.

- i. Provision has been made in the cost estimate for plantation at ten times the number of vulnerable trees.
- ii. Around 1800 trees shall be planted under compensatory plantation.

Table No. 7.3 Compensatory tree plantation phasewise

Phases	No. of trees to be cut	No. of trees to be planted	Location of compensatory tree plantation
Phase-I	177	1800	270 No. around periphery of Seena Venna Kulam 1530 No. at Tharuvaikulam site

- In phase I, 270 No. of trees shall be planted around the periphery of Seena Venna Kulam & 1530 No. of trees shall be planted at Tharuvaikulam site (Lat: 8°53'31.33"N Long: 78°10'14.34"E) having area of 503 acres (Out of 503 acres land 36 acres is under solid waste management purpose). Distance of site is about 16 km from proposed SWD.
- iii. TCMC will carry out the maintenance activities of the plantation.
- iv. List of suggested species of trees for the compensatory plantation is given in below table

Table 7.4 List of Compensatory Tree Plantation

Botanical Name	Family	Tamil Name
<i>Acacia auriculiformis</i>	Mimosaceae	Kaththi Karuvel
<i>Acacia catechu</i>	Mimosaceae	Katha
<i>Acacia ferruginea</i>	Mimosaceae	Parambai
<i>Actinodaphne hookeri</i>	Lauranceae	Thali
<i>Adenanthera pavonia</i>	Mimosaceae	Anai-kundumani
<i>Adina cordifolia</i>	Rubiaceae	Manja-kadambai
<i>Aegle marmelos</i>	Rutaceae	Vilvam
<i>Ailanthus excelsa</i>	Simarubaceae	Perumarautta
<i>Albizia amara</i>	Mimosaceae	Usil
<i>Alstonia scholaris</i>	Apocynaceae	Elilappalai
<i>Anogeissus latifolia</i>	Combretaceae	Vekkali
<i>Anthocephalus cadamba</i>	Rubiaceae	Vella-kadambu
<i>Azadirachta indica</i>	Meliaceae	Veppam
<i>Bambusa arundinocia</i>	Poaceae	Mullumungil
<i>Bauhinia purpurea</i>	Caesalpiniaceae	Mandarai
<i>Bauhinia recemosa</i>	Caesalpiniaceae	Athi
<i>Bridelia retusa</i>	Euphorbiaceae	Mullu-vengai

<i>Caesalpinia bounducella</i>	Caesalpinaceae	Kazhichi-kai
<i>Calophyllum inophyllum</i>	Guttiferae	Punnai
<i>Cassia fistula</i>	Caesalpinaceae	Arakkuvadam
<i>Celiba pentandra</i>	Bombacaceae	Ulagamaram
<i>Clerodendrum serratum</i>	Verbenaceae	Chiru tekku
<i>Dalbergia sissoo</i>	Papilionaceae	Sisoo
<i>Delonix regia</i>	Caesalpinaceae	Mayil-konnai
<i>Dendrocalamus strictus</i>	Poaceae	Bamboo
<i>Diosphyros melanoxylon</i>	Ebenaceae	Ebony karuunthumbi
<i>Ficus benghalensis</i>	Moraceae	Al
<i>Ficus hispida</i>	Moraceae	Pei-athi
<i>Guazuma tomentosa</i>	Sterculiaceae	Kattu Utharaksham
<i>Lawsonia inermis</i>	Lythraceae	Marudani
<i>Mallotus philippensis</i>	Euphorbiaceae	Kapila
<i>Melia azadirachta</i>	Meliaceae	Vepa
<i>Mimusops elangi</i>	Sapotaceae	Magizham
<i>Saraca indica</i>	Caesapiniaceae	Asokan
<i>Soymida febrifuga</i>	Meliaceae	Semmaram
<i>Terminalia arjuna</i>	Combretaceae	Vellai-maruthu

7.1.10 SAFETY REQUIREMENTS FOR MAINTENANCE OF DRAINS

The inspection doors are provided at a distance of 10m to facilitate maintenance only through machineries and equipments avoiding manual entry.

However in case of any need for manual maintenance the following measures shall beensured.

- A competent person should carry out a risk assessment and make recommendationson safety and health measures before undertaking work in confined space.
- Allow only certified workers to work in the confined space.
- Provide adequate ventilation.
- Isolate the confined space.
- Monitor the air quality throughout the entire working period by means of a gasdetection device.
- A person should be stationed outside the confined space to monitor the weathercondition and keep communication with the workers inside.if required ensure the use of approved breathing apparatus
- Appropriate emergency procedures shall be formulated to deal withimminent danger.
- Instructions, training and advice shall be provided to all workers to be workingwithin a confined space.

7.1.11 ENVIRONMENTAL MANAGEMENT PLAN FOR SWD

The management measures which are to be implemented during various phases of implementation of the proposed SWD to Thoothukudi Corporation have been provided in Table 7.5. The general Environmental, Health and Safety guidelines of WorldBank shall also be applied for relevant stage and activities in implementing the project.

Table 7.5 A Phase wise Environmental Management Plan

Sr. No.	Potential Impact	Mitigation Measures	Responsible Agencies
1.0	Design Phase Measures		
1.1	Prevention of flooding	The drains shall be constructed to handle the maximum rainfall of 45.27mm/hr	
1.2	RainwaterHarvesting &Recharge structures	Rain water harvesting arrangements are proposed to be installed in primary drain wherever such arrangement is possible. In phase I 90 no. of RWH pits will be constructed. The rain water harvesting is proposed at 500m distance and it comprises of 150mm dia. bore of about 3.0m depth fitted with PVC slotted pipe and fixing of 1200mm dia. RCC pipe at its upper end just below the ground level. The RCC pipe is proposed to be fitted with filter media to exclude the silt entering into the water table.	TCMC
1.3	Sediment Control	For control of sediments it is proposed to construct Silt pits only in newly constructed tertiary drains and will be in the form of depression of about 45 to 60 cm for about 1.50 m length in those channels so that the sediments are deposited in the silt pits and settle over there which can be removed periodically.	TCMC
1.4	Prevention of solid waste into drains	<ul style="list-style-type: none"> Micro drains shall be constructed as box type drain in RCC with cover on top which will curtail dumping of solid waste in drains. Major micro drains belonging to Corporation of Thoothukudi will be provided with top cover in MS frame with wire mesh to avoid dumping solid waste. 	TCMC
1.5	Natural Landforms at CRZ	Care shall be taken so that natural landforms within CRZ shall not be affected by the proposed works of the Storm Water Drains.	TCMC
1.6	Effect of Outfall	<ul style="list-style-type: none"> Proper arrangement at the connection of outfall flow to the receiving body through stone pitching/apron is proposed to avoid scouring of bed of receiving body. Care shall be taken to properly protect the bed of receiving 	TCMC

		<p>body as per provision in the project.</p> <ul style="list-style-type: none"> No water supply intake work is located downstream of proposed outfalls. Hence no effect on drinking water sources expected. Quantity of flow in receiving body during storm drain discharge period is adequate to achieve proper dilution. 	
1.7	Safety in maintenance	Inspection doors shall be provided at an interval of 10m to facilitate maintenance activities only by machineries.	Contractor/TCMC
2.0	Pre-construction & Construction Phase (The contractor will prepare C-ESMP prior to commencement of works to address various Environmental and social impacts)		
2.1	Consents, permits, clearances, No Objection Certificates (NOCs), etc.	<ul style="list-style-type: none"> Obtain all necessary consents, permits, clearance, NOCs, etc. prior to start of civil works. (For details refer Table No-4.3 of the EIA report) Ensure that all necessary approvals for construction to be obtained by contractor are in place before start of construction. Acknowledge in writing and provide report on compliance all obtained consents, permits, clearance, NOCs, etc. Ascertain ownership of the construction site(including ponds) and obtain the required permissions to undertake work on the site of the work. Obtain consent from Batch Mixing Plant from supplier for supplying premix concrete for the works involved. Obtain specific labour license from appropriate authorities for the project/work under consideration. For trees identified for cutting, obtain prior permission from the competent authority, TCMC prior to commencement of work. Contractor shall ensure compliance to applicable legislations as in the Appendix 1 of EIA report. 	TCMC/ Contractor
2.2	Tree Cutting	<ul style="list-style-type: none"> Provide adequate protection to the trees to be retained with tree guards (e.g. Masonry treeguards, Low level RCC tree guards, Circular Iron Tree Guard with Bars) as required. Take adequate care to determine root protection zone and minimize root loss. Trees shall be removed from the construction sites before commencement of 	Contractor/ TCMC

		<p>construction</p> <ul style="list-style-type: none"> • TCMC shall undertake afforestation in nearby areas selected by TCMC authorities. 	
2.3	Utility Relocation	<ul style="list-style-type: none"> • Identify the common utilities that would be affected such as: telephone cables, electric cables, electric poles, water pipelines, public water taps, etc. • The existing pipelines which are to be protected/strengthened shall be carefully protected during construction to avoid interruptions in the services. • Affected utilities shall be relocated with prior approval of the concerned agencies before construction starts. • Where ever the entry and exit to houses/ establishments are affected due to construction activities, alternate temporary arrangement for crossing over shall be provided. • Water Supply Lines crossing the drains are identified and Contractor shall take care of these lines while the time of construction. 	TCMC/ Concerned departments/ Contractor
2.4	Baseline Parameters	<ul style="list-style-type: none"> • Base line parameters shall be recorded and ensured conformance till the completion of the project. • The contractor shall undertake periodical monitoring of air, water, noise and soil quality through an approved monitoring agency. The parameter to be monitored, frequency and duration of monitoring plan shall be prepared. • Adequate measures shall be taken and checked to control any pollution and report be sent to the Engineer. • The quality of water used for instruction labour shall be of potable nature and if water from wells is used for this purpose regular disinfection of those wells shall be undertaken by the contractor. 	Contractor/ TCMC
2.5	Planning of temporary Traffic arrangements	<ul style="list-style-type: none"> • Temporary diversion will be provided with the approval of the engineer. Detailed traffic control plans will be prepared and submitted to the engineers for approval, one week prior to commencement of works. • The traffic control plans shall contain details of temporary diversion, details of arrangements for construction under traffic, details of traffic arrangement after cessation of work each day, SIGNAGES, safety measures for transport of hazardous materials and arrangement of 	Contractor/ TCMC

		<p>flagmen.</p> <ul style="list-style-type: none"> All signages, contact numbers for emergency contact – of authorities, ambulance etc. First aid, toilets, water facilities, OHS for workers shall be provided on heavy traffic roadsides. <p>The guidance for traffic management provided in Section 7.1.8 of the EA report shall be referred to for preparation of the traffic plan.</p>	
2.6	Temporary flooding during Construction activity.	<ul style="list-style-type: none"> De-silting activity shall be scheduled during non-flooding season. Proper drainage arrangements to be made, to avoid the overflowing of existing drains due to construction activity. 	Contractor/ TCMC
2.7	Prevention of accidents and safety Issues of existing services	<ul style="list-style-type: none"> Prevention of accidents involving human beings, animals or vehicles falling or accidents during construction period. This needs to be ensured with proper barricading, signage boards and lighting etc. The project engineer of TCMC will plan and direct the contractor to execute the work progressively so that the length of the open excavated trench is minimized in order to reduce possible accidents 	Contractor/ TCMC
2.8	Barricading site	The construction area should be barricaded at all time in a day with adequate strong stable barricades (which would by itself not be a safety issue), marking, flags, reflectors etc. for safety of general traffic movement and pedestrians.	Contractor
2.9	Drainage flow	<ul style="list-style-type: none"> Alternate arrangement like diversion of the drainage be ensured to allow the natural flow. It shall be ensured that none of the construction activities affect the natural flow of the drainage. For areas having mostly hutment dwellers with no facility of individual toilets TCMC shall arrange for construction of public toilets or shall encourage people for their own toilets and thereby avoid drainage flow into the primary drains such as Mullakkadu Odai/Channel. 	Contractor/ TCMC
2.10	Storage of materials	<ul style="list-style-type: none"> No construction materials should be stored on the road, on top of or beside drains and footpaths, or on any other public area as this may restrict public access to these utilities. If the construction /excavated materials are required to be stored near the excavated trenches then such storage shall be at least 1.0 m away from the 	Contractor/TCMC

		<p>edge of the trench to avoid side slips and accident thereby.</p> <ul style="list-style-type: none"> The contractor shall identify the site (in consultation with TCMC) for temporary use of land for construction sites /storageof construction materials, etc. Site for storage of construction materials to be identified without affecting the traffic andother common utilities, and the quality of the construction materials. Construction materials should only be stored and prepared on the site if they do notobstruct the road or any surrounding public utility. Construction materials should only betransported to the worksite as and when required for construction 	
2.11	Use of modern machineries	Using of modern machineries such as JCBs, backhoes etc, shall be used to minimize the construction period, it will reduce the construction period impacts to the nearby residents.	Contractor
2.11.1	Procedures to be followed for use of heavy equipment like excavators	<ul style="list-style-type: none"> Alert signals such as danger light blinkers, flags etc. near the work area of heavy earth excavation machinery shall be provided to avoid accidents. Use of heavy machinery below electrical transmission lines shall be avoided unless permitted by the concerned authority. Precautions against ground slides near trenches shall be taken. Arrangements to keep general public away from the machinery & work site by providing barricading shall be made and maintained. The work near the underground utilities shall be done carefully and disruptions of the services through those utilities shall be avoided. Special safety precautions shall be taken especially where trenches are deep there is risk of collapse of trenches and/or damage to surrounding buildings, risk to pedestrians and traffic. Maintain adequate slopes to trenches. Necessary precautions such as bracing / shoring in the trench will be provided for trenches of more than 1.2 m deep. 	Contractor
2.12	Dust pollution near settlements	<ul style="list-style-type: none"> All earth work will be protected in manner acceptable to the engineer to minimize generation of dust. Area under construction shall be covered & 	Contractor

		<p>equipped will dust collector.</p> <ul style="list-style-type: none"> • Construction material shall be covered or stored in such a manner so as to avoid being affected by wind direction. • Unpaved haul roads near / passing through residential and commercial areas to be watered thrice a day. • Trucks carrying construction material to be adequately covered to avoid the dust pollution and to avoid the material spillage. • Sprinkling of water to be done at regular intervals at places of work to protect the nearby inhabitants and road users. 	
2.13	Protection of residential / Sensitive receptors	<ul style="list-style-type: none"> • Provide pedestrian/vehicular access in all the locations; provide wooden/metal planks with safety rails over the open trenches at each house/important property to maintain the access. • Inform the affected local population in advance about the workschedule, a week before, and a day before to start of work Plan and execute the work in such a way that the period of disturbance/ loss of access is minimum. • Keep the site free from all unnecessary obstructions; • Notify affected public by public information notices, providing sign boards informing nature and duration of construction works and contact numbers for concerns/complaints. Provide information to the public through media – newspapers and local cable television (TV) services • At work site, public information/caution boards shall be provided including contact for public complaints • Noisy construction operations in residential and sensitive areas should be done only between 7.30 am and 6.00 pm. • Preventive maintenance of construction equipment and vehicles to meet emission standards and to keep them with low noise. • Provision of enclosing generators and concrete mixers at site. • Sound barriers shall be installed during the construction phase to protect the inhabited areas from the noise from construction activities. • Adequate barricading and safety measures to protect dust pollution and 	Contractor

		noise impacts on sensitive receptors like schools and hospital etc due to vehicle movement to be ensured prior to the start of work and their effectiveness to be checked during construction and operation phase.	
2.14	Vehicular noise pollution at residential /sensitive receptors.	<ul style="list-style-type: none"> • Idling of temporary trucks or other equipment should not be permitted during periods of loading / unloading or when they are not in active use. The practice must be ensured especially near residential / commercial / sensitive areas. • Stationary construction equipment will be kept at least 500m away from sensitive receptors. • All possible and practical measures to control noise emissions during drilling shall be employed. The TCMC may direct to take adequate controls measures depending on site conditions. 	Contractor
2.15	Noise from vehicles, plants and equipments	<ul style="list-style-type: none"> • Use of less noise generating cutting equipment's, provide personal protective equipment's such as ear plugs/muffs and other safety measures to labourers. In addition the concrete mixture to be used for construction works will be prepared in a location away from the locality to minimize the noise generated from the machinery. • Servicing of all construction vehicles and machinery will be done regularly and during routine servicing operations, the effectiveness of exhaust silencers will be checked and if found defective will be replaced. • Maintenance of vehicles, equipment and machinery shall be regular and up to the satisfaction of the Engineer to keep noise levels at the minimum. 	Contractor
2.16	Labour camp & facilities	<p>Follow the rules and regulations regarding labour laws and labour facilities listed for guidance in the Appendix -1 of EIA report.</p> <p>Setting up of labour camps needs to be done as per the procedures. Adequate potable water facilities, sanitation and drainage etc., in conformity with the Indian labour laws shall be ensured.</p> <p>The contractor shall also guarantee the following:</p> <ul style="list-style-type: none"> • Land required for labour camps to be arranged by contractor. select a camp site away from residential areas (at least 100 m buffer shall be maintained) • No labour camps shall be located in CRZ areas. 	Contractor

		<ul style="list-style-type: none"> • Avoid tree cutting for setting up camp facilities • Camp site shall not be located near (100 m) from water bodies, flood plains flood prone/low lying areas, or any ecologically, socially, archeologically sensitive areas • Separate the workers living areas and material storage areas clearly with a fencing and separate entry and exit. • 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. Ensure safe living in case of vagaries of weather. • The location, layout and basic facility provision of each labour camp will be submitted to Engineer prior to their construction. • The construction will commence only upon the written approval of the Engineer. • 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. • The Contractor shall construct and maintain all labour accommodation in such a fashion that uncontaminated water is available for drinking, cooking and washing. • Camp shall be provided with proper drainage, there shall not be any water accumulation • Provide sanitation facilities for employees/labourers such that sullage and sewage to be disposed in environmentally appropriate/ sanitary way. • Supply of sufficient quantity of potable water (as per IS) in every workplace/labor camp site at suitable and easily accessible places and regular maintenance of such facilities. • The sanitation system for the camp shall be provided and operated in such a fashion that no health hazards occurs and no pollution to the air, ground water or adjacent water course take place. Ensure adequate water supply 	
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		<p>in all toilets and urinals. Separate toilets, wash areas, facilities. Rest rooms etc for male and female staff / labourers shall be provided..</p> <ul style="list-style-type: none"> • Employees shall be trained in the storage and handling of materials which can potentially cause soil contamination. • 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.. • No tools / equipments, to be strewn around in work area. Electricals to be planned and provided without any harm to workers, hosts. • Remove all wreckage, rubbish, or temporary structures which are no longer required. • 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 	
2.17	Pollution from Construction Wastes	<ul style="list-style-type: none"> • All waste arising from the project is to be disposed off in the manner that is acceptable by the Engineer. • The engineer shall certify that all liquid wastes disposed off from the sites meet the discharge standard. 	Contractor
2.18	Pollution from Fuel and Lubricants	<ul style="list-style-type: none"> • The contractor shall ensure that all construction vehicle parking location, fuel/lubricants storage sites, vehicle, machinery and equipment maintenance and refueling sites will be located at least 500 m from sensitive receptors. • All location and lay-out plans of such sites shall be submitted by the Contractor prior to their establishment and will be approved by the Engineer. • Contractor shall ensure that all vehicle/machinery and equipment operation, maintenance and refueling will be carried out in such a fashion that spillage of fuels and lubricants does not contaminate the ground. • Contractor shall arrange for collection, storing and disposal of oily wastes to the pre-identified disposal sites (list to be submitted to Engineer) and approved by the Engineer. All spills and collected petroleum products will be disposed off in accordance with MoEF and state PCB guidelines. 	Contractor

		<ul style="list-style-type: none"> Engineer will certify that all arrangements comply with the guidelines of PCB/ MoEF or anyother relevant laws. 	
2.19	Chance found Flora & Fauna	<ul style="list-style-type: none"> The contractor will take reasonable precaution to prevent his workmen or any other persons from removing and damaging any flora (plant/vegetation) and fauna (animal) unless permitted by Engineer-in-Charge. Fishing in any water body and hunting of any animal shall be prevented. If any wild animal is found near the construction site at any point of time, the contractor will immediately upon discovery thereof acquaint the Engineer and carry out the Engineer's instructions for dealing with the same. The Engineer will report to the nearby forest office (range office or divisional office) and will take appropriate steps/ measures, if required in consultation with the forest officials. 	Contractor/ TCMC
2.20	Chance found archeological property	<ul style="list-style-type: none"> All fossils, coins, articles of value of antiquity, structures and other remains or things of geological or archaeological interest discovered on the site shall be the property of the Government and shall be dealt with as per provisions of the relevant legislation. The contractor will take reasonable precautions to prevent his workmen or any otherpersons from removing and damaging any such article or thing. He will, immediatelyupon discovery thereof and before removal acquaint the Engineer of such discoveryand carry out the SC's instructions for dealing with the same, waiting which all workshall be stopped. The Engineer will seek direction from the Archaeological Survey of India (ASI) beforeinstructing the Contractor to recommence the work in the site. 	Contractor/ TCMC
2.21	Disposal of oil & grease	A suitable site should be identified for safe disposal / without contaminating the source, in relatively low lying areas, away from the water bodies etc., as approved by the Engineer & as per specific procedures.	Contractor/ TCMC
2.22	Safety Aspects	<ul style="list-style-type: none"> Adequate precautions shall be taken to prevent the accidents and from the machineries. All machines used shall confirm to the relevant Indian standards Code and shall be regularly inspected by the TCMC. Where loose soil is met with, shoring and strutting shall be provided to avoid collapse of soil. 	Contractor

		<ul style="list-style-type: none"> • Protective footwear and protective goggles to all workers employed on mixing of materials like cement, concrete etc. • Welder's protective eye-shields shall be provided to workers who are engaged in welding works. • Earplugs shall be provided to workers exposed to loud noise, and workers working in crushing, compaction, or concrete mixing operation. • The contractor shall supply all necessary safety appliances such as safety goggles, helmets, safety belts, ear plugs, mask etc to workers and staffs. • The contractor will comply with all the precautions as required for ensuring the safety of the workmen as per the International Labor Organization (ILO) Convention No. 62 as far as those are applicable to this contract. • 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 etc, and for labour welfare are adhered to. Guidance list of labour regulations is provided in Appendix I of EIA report. • 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. 	
2.23	Risk from Electrical Equipments	<p>The Contractor shall take all required precautions to prevent danger from electrical equipment and ensure that -</p> <ul style="list-style-type: none"> • No material will be so stacked or placed as to cause danger or inconvenience to any person or the public. • All necessary fencing and lights will be provided to protect the public in construction zones. • All machines to be used in the construction will conform to the relevant Indian Standards (IS) codes, will be free from patent defect, will be kept in good working order, will be regularly inspected and properly maintained as per IS provision and to the satisfaction of the Engineer. 	Contractor
2.24	First Aid	<p>The contractor shall arrange for:</p> <ul style="list-style-type: none"> • A readily available first aid unit including an adequate supply of sterilized 	Contractor

		<p>dressing materials and appliances as per the Factories Rules in every work zone</p> <ul style="list-style-type: none"> • Availability of suitable transport at all times to take injured or sick person(s) to the nearest hospital. • Adequate training shall be provided to workers on first aid. 	
2.25	Informatory Signs and Hoardings	The contractor shall provide, erect and maintain informatory/safety signs, hoardings written in English and local language, wherever required or as suggested by the Engineer.	Contractor/ TCMC
2.26	Disposal of de-silted / Excavated material, Construction and other waste.	<p>The excavated /de-silted material shall be disposed off without any accumulation. The soil excavated from the canal and river shall be tested for quality, adequately treated with methods like bioremediation and proper reuse option explored. The rest may be safely disposed.</p> <p>The vehicles conveying earth will be covered to avoid spreading of respirable suspended particulate matter & dust in the ambient air. Also, shall not drip the water from the silt while transporting. Excavated material should be transported each day without storing on site for more than a day. When stored on site it should not create harm / safety issues of any sort to people / traffic; storage area shall be well marked / contained. To be well contained and managed at disposal site too</p> <p>The disposal shall be done in the existing dump yards of Thoothukudi Corporation at Tharuvaikulam or any other site identified by TCMC. 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. The disposed stuff shall be properly spread as per the directive of the Engineer.</p> <p>The following shall be ensured during silt disposal</p> <ul style="list-style-type: none"> • The dumping does not impact natural drainage courses • No endangered / rare flora is impacted by such dumping • Settlement area located at least 1.0 km away from the site. • Should be located in non residential areas located in the down wind side located at least 100m from the designated forest land. • Avoid disposal on productive land should be located with the consensus of the local community, in consultation with the engineer 	Contractor/ TCMC

		<ul style="list-style-type: none"> All vehicles conveying surplus stuff (for permanent disposal or temporary stacking) shall be covered to avoid material spillage and dust problem. 	
2.27	Clearing of construction camps and restoration	<ul style="list-style-type: none"> Contractor to prepare site restoration plans, the plan is to be implemented by the contractor prior to demobilization. On completion/closure of the works, all temporary structures will be cleared away, all rubbish cleared, buried septic tanks or trenches filled in and effectively sealed off and the site left clean and tidy, at the contractor's expenses, to the entire satisfaction of the engineer. Residual topsoil will be distributed on adjoining / proximate barren / rocky areas as identified by the engineer in a layer of thickness of 75 mm – 150 mm. 	Contractor
2.28	Project implementation	It shall be ensured that the Environmental, Health and Safety guidelines of World Bank are adhered to as applicable for activities during construction.	Contractor/ TCMC
2.29	Grievance Redressal	Any grievance arising during implementation of the project shall be redressed by the TCMC through mechanism identified and a committee shall be established prior to start of work.	Contractor/ TCMC
3.0	Operation Phase		
3.1	Maintenance	<p>It shall be ensured by the TCMC that drains are not clogged.</p> <p>The following practices should be adopted in maintaining storm water drains:</p> <ul style="list-style-type: none"> Drains shall be regularly inspected and cleaned especially prior to monsoons. All damaged or missing drain covers should be replaced immediately Rubbish and silt that has been removed from the drainage system should not be left alongside the drain and shall be immediately disposed in pre-identified site with necessary precautions. Occupational Health and Safety(OHS) to be ensured for all workers, and emergency aid shall be made available, It shall be ensured that the Environmental, Health and Safety guidelines of World Bank (Generic and Water & Sanitation) are adhered to relevant activities during operation. 	TCMC
3.2	Impairment of receiving	<ul style="list-style-type: none"> Avoid mixing of wastewater from household, commercial, industrial and other 	TCMC

	water quality due to mixing of waste water	<p>establishments.</p> <ul style="list-style-type: none"> • Provision for connecting domestic liquid waste to sewerage system is to be made during drain construction to avoid mixing of wastewater. • Periodical monitoring shall be carried out and sources of wastes/ effluent etc are to be identified by the TCMC. TCMC may initiate action to ensure proper linking of such connections to other waste disposal systems and it shall be ensured that the drains carry only the rainwater. • In case of any industrial effluent identified, necessary action be taken in coordination with the TNPCB. 	
3.3	Nuisance due to clogging of drains, formation of mosquito breeding grounds etc.,	<ul style="list-style-type: none"> • Ensure timely de-silting of drains • Create awareness among the people not to throw garbage and other waste into the drains 	TCMC
3.4	Disposal of Storm water	<ul style="list-style-type: none"> • Mixing of wastewater from households, commercial, industrial and other establishments will be avoided through improved sewerage system in the project area through periodical monitoring of water quality. • Possibility of reusing the stormwater for secondary uses with minimum treatment shall be explored and implemented. 	TCMC
3.5	Tree Planting & Protection	<ul style="list-style-type: none"> • Plantation of trees shall be carried out along the periphery of Seena Venna Kulam and at Tharuvaikullam site. • Masonry tree guards, Low level RCC tree guards, Circular Iron Tree Guard with Bars, use of plate compactors near trees may also be considered where necessary. Trees of sufficient height shall be planted (around 1m) to ensure longevity • Growth and survival of trees planted shall be ensured and monitoring done at least for a period of 3 years. Survival status shall be monitored on monthly basis by Engineer in-charge. 	TCMC
3.6	Flood Management	Flood management system may be developed with forecasting and warning to protect areas prone to flooding and action be taken as necessary, like bailing out of water, relocation of residents to other locations etc.	TCMC

Table 7.5B Typical Hazards, Risks & Safety controls for workers

Activity	Hazards	Risk	Typical safety controls to be implemented	Responsibility
1.Excavation	Falls into trenches or excavations Tripping over equipment,debris and spoil Excavated material or other objects falling on workers Exposure to underground services or overhead electrical cables Hazardous atmosphere (noxious gases/lack of oxygen)	Engulfment of a. Personal injury/death of contractors personnel/ public/private persons. b.. Loss to Private/ Public Property or contractors property.	Remove debris & excavated soil atleast 1m away from trench edge. Arrange Barricades with reflectors, signages; IEC to hosts; and workersto protect workers/general public from falling into excavations Identify and locate overhead power line and underground services Know soil types and what sloping, shoring or pre-fabricated, hydraulic or engineer system are required Prepare emergency plans Workers shall not perform work in trench unless another worker is working above ground. Obtain Insure policy against probable losses.	Contractor
2.Delivery and unloading of materias	Materials may move/roll or be tampered	Injury to persons generally Lifting injury Swinging load	Provide secure stockpile area for pipes and fittings. Unload and stack pipes strictly in accordance with the manufacturers' recommendations Correct manual handling techniques. Use mechanical aids where possible. Maintain control of loads when lifting & moving. Carry pipes close to ground while moving.	Contractor
3.Secure site	Public safety Traffic Inadequate access/egress	Injury to a member of the public Personal injury to members of the public, contractors and employees Vehicle Accidents Slips, trips and falls, abrasions, strains	Provide the appropriate fencing and/or barricades as per site risk assessment. Apply appropriate signage and pedestrian control. Devise and implement system for site inspection and security. Proper traffic control plan Keep area clean & clear of obstacles Conduct site inspection to ensure access/egress is	Contractor

		and sprains; manual handling injuries such as back damage	adequate for the task activities.	
4. Locate existing services	Existing underground services	Explosion, electrocution, damage service,	Check relevant Authority (e.g. power, water, gas, council) records for location of services. If in doubt uses experienced/accredited service locators. When using hand prodders to locate pipes, prodders must never be driven in to the ground by hammers or other implements	Contractor
5. Materials Checking	Defective materials	Risk of various injuries	Visual inspection of materials.	Contractor
7. Cut-in to existing pipeline	Failure of existing pipeline under pressure	Injury from high pressure	Use PPE. Ensure adjacent stop valves are operational / closed Secure adjacent valves against movement. Relieve pressure in system.	Contractor
8. Reconnecting house services	High pressure water Welding House services	Injury from high pressure Burns Electrocution	Any such activity shall be in co-ordination with the concerned authority. Use PPE. Relieve pressure in system. Earth straps and insulating gloves to be used as services are used for household earthing.	Contractor
9. Restoration of site	Inadequate compaction Construction refuse Inadequate re-surfacing High hydraulic/pneumatic pressures	Public hazard Injury from high pressures in pipelines blowouts of plugs	Compaction to specified standard. Site cleared of debris and refuse. Re-surface appropriately. Do not leave gaps in turf or leave uneven surface. Erect fence around hazardous areas until restored and safe. Use of hazardous materials including asbestos for any	Contractor

			work shall not be permissible.	
General activities	<p>Inadequate training, consultation, planning and improvisation</p> <p>Misuse of equipment/fire hazards</p> <p>Exposure to ultra violet light, glare</p> <p>Weather Conditions (e.g. hot, cold wet, flooding/inundation, electrical storms, high winds)</p> <p>Slippery surfaces</p> <p>Untidy site</p> <p>Storage of materials</p> <p>Storage of plant</p>	<p>Task specific injuries due to inexperience, inadequate consultation or failure to provide appropriate equipment</p> <p>Fire/Explosion</p> <p>Skin cancer, sunburn, eye damage</p> <p>Dehydration and dizziness</p> <p>Slips and falls</p> <p>Materials may be dislodged and fall onto people or property particularly when site is unattended</p> <p>Public Safety</p>	<p>All personnel on-site to be appropriately inducted.</p> <p>All personnel on-site to be suitably qualified.</p> <p>Competent supervision to be provided on-site.</p> <p>Care to be taken when refuelling machinery with petrol to ensure engines aren't running and there are no naked flames in the vicinity.</p> <p>Gas equipment must be used strictly in accordance with the manufacturers safe operating procedures.</p> <p>All personnel working on the site are to be trained in the correct operation of the tools and equipment they are using.</p> <p>All tools and equipment are to be serviceable and in safe condition</p> <p>All electrical tools are to be fitted with current test tags.</p> <p>No work during high fire danger unless dry vegetation is cleared and/or watered down prior to carrying out hot work.</p> <p>Protective clothing, sunscreen, flap on hard hat. AS rated sunglasses.</p> <p>Supply adequate drinking water in work area.</p> <p>Provide protection from UV rays.</p> <p>Non-slip safety footwear to be worn on all worksites.</p> <p>Extreme care when working in wet and slippery areas.</p> <p>Personnel should never run on worksite.</p> <p>Keep worksite clean and tidy at all times.</p> <p>Materials to be stored in a safe manner.</p> <p>All materials to be secured by suitable chocks,</p>	Contractor

			sandbags or other means. All pipes not laid during the course of a day are to be returned to the stockpile and secured appropriately. Store/park plant & equipment off site & in a secure area.	
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7.2 ENVIRONMENTAL MONITORING PLAN

To monitor the extent of environmental impact of the proposed project, the contractor has to periodically monitor the ambient environmental quality along the proposed project area. The monitoring requirement for the different environmental components is presented in table below

Table 7.6 Environmental Monitoring Plan

Air Quality Monitoring	
Project stage	Construction
Parameter	PM ₁₀ , PM _{2.5} , SO ₂ , NO _x , CO and Pb
Sampling Method	Use method specified by CPCB for analysis
Standards	National Ambient Air Quality Standards 2009, Air (Prevention and Control of Pollution) Act, 1981
Frequency	Once every season except monsoon during construction period
Duration	As per CPCB guidelines for monitoring
Location	Sensitive locations, especially in the downwind direction along the Drain alignment.
Measures	Wherever air pollution parameters increase above specified standards, additional measures as decided by the engineer shall be adopted
Implementation	Contractor through approved monitoring agencies
Supervision	TCMC
Water Quality Monitoring	
Project stage	Construction & Operation period
Parameter	Parameters for Surface water quality standards (IS; 2296) Water pH, TDS, Total hardness, Sulphate, Fluorides, Chloride, Fe, Pb for groundwater.
Sampling Method	Grab sample to be collected and analysis as per Standard Methods for Examination of water and Waste water.
Standards	Indian standards for Inland Surface Water (IS; 2296, 1982) and for Drinking water (IS; 10500, 2012)
Frequency	Once every season during construction and during operation period.
Duration	Grab sampling
Location	Locations representing water quality in the drain, S.V.Kulam, Mullikulam and ground water Quality
Measures	At locations of variation in water quality/increased pollution, remedial measures to be adopted /all inflow channels shall be checked for pollution loads
Implementation	Contractor through approved monitoring agencies
Supervision	TCMC
Noise Level Monitoring	
Project stage	Construction
Parameter	Noise levels on dB (A) scale.
Special guidance	<ul style="list-style-type: none"> Free field at 1 m from the equipments whose noise level are being determined. Equivalent noise levels using an integrated noise level meter kept at a

	distance of 15m from edge of pavement
Standards	National Ambient Air Quality Standards in respect of Noise, Noise Pollution (Regulation and Control) Rules, 2000
Frequency	Seasonal during construction period
Duration	Reading to be taken at 15 seconds interval for 15 minutes every hour and then averaged
Location	<ul style="list-style-type: none"> Wherever the contractor decides to locate the equipment yard. At sensitive locations such as school, hospitals etc along the alignment.
Measures	In case of noise levels causing disturbance to the sensitive receptors, management measures as suggested in the EMP shall be carried out.
Implementation	Contractor through approved monitoring agencies
Supervision	TCMC
Soil Quality Monitoring	
Project stage	Construction & Operation
Parameter	Soil quality parameters (Pb, SAR and Oil & Grease, monitoring silt for presence of toxic metals , etc)
Sampling Method	Sample of soil collected to be acidified and analysed using absorption Spectrophotometer
Standards	Threshold for each contaminated set by IRIS database of USEPA until national standards are promulgated
Frequency	During the pre monsoon post monsoon seasons each year for the entire construction and operation phase
Duration	Grab sampling
Location	At sample locations in the receiving waterbodies, at the places of dumping silt, excavated earth
Measures	At location of increased in pollution levels, source shall be identified and measures adopted.
Implementation	Contractor through approved monitoring agencies
Supervision	TCMC

Apart from the above mentioned monitoring requirements, any major accidents / spillage during bulk transport of hazardous materials by the contractor, depending on the type of spillages / accidents, the parameters to be monitored will be decided by the engineer and should be carried out by the contractor through approved monitoring agencies and supervised by the Implementing agency at their own cost

7.3 FORMATS FOR REPORTING:

Formats for reporting / monitoring the progress / parameters achieved will be finalized in consultation with the successful bidder.

7.3.1 ENVIRONMENTAL COMPLIANCE REPORT

The contractor shall submit a monthly progress report as per the reporting format approved by the Engineer on the status of the implementation of the EMP and get it duly approved by the Engineer for its compliance and for proceeding with the work. The Engineer and the Environmental and Social Safeguard (ESS) Manager, who will have access and authority to monitor the status based on the same and for

which necessary facilities shall be made by the contractor. Database on accidents and near misses related to SWD construction shall be maintained and reported as soon as the event occurs. Monthly compliance report shall be provided by PMC / IA to TNUIFSL.

7.4 COST ESTIMATES FOR ENVIRONMENTAL MANAGEMENT PLAN

The budget proposed for implementation of environmental management measures proposed in the SWD to TCMC is given in Table below.

Table 7.7 Cost estimate for EMP Phase- I

Sr. No.	Management Activities	Unit	Rate	Amount	EMP Implementation cost		Remark
				(Rs.)	Cost proposed with separate Bid document.	Cost covered in main project work	
A	EMP Cost estimate (During Construction Phase)						
1	Sprinkling of water for dust suppression	Job work	-	-	-	-	This scope of work is covered under technical specification of bid document. Vide clause No. 1.6
2	Compensatory plantation after the completion of the activity (plantation of 1800 trees and landscaping works)	No	666	11,98,800	----	11,98,800	270 Trees are proposed to be planted at S.V Kulam, and 1530 trees are proposed to be planted at Thiruvaikulam ground (Under Package-III)
3	Traffic management measures viz. temporary barriers and proper signage	Job work	----	----	----	----	This scope of work is covered under technical specification of bid document. Vide clause No. 1.8
4	Lead and lift for excavated silts up to dumping area	Job work	----	----	----	----	This scope of work is covered under Estimate of S.V Kulam Vide Item no-06 (Under Package-III)
5	Labour camp management viz. provision of Proper drainage, sanitation, water supply and temporary camps for habitation of labours	Job work	----	----	----	----	This scope of work is covered under technical specification of bid document. Vide clause No. 1.10
6	Provision for temporary arrangements to cross drains during execution	Job work	----	----	----	----	This scope of work is covered under technical specification of bid document. Vide clause No. 2.7

7	Provision for rain water harvesting	No	----	----	----	----	The provision of 40 no of RWH are made at S.V Kulam and for all Odai's RWh are proposed at 500m interval.
8	Utility Relocation or Providing chairs to Water Supply Lines.	Job work	----	----	----	----	The Provision is made in Main DPR.
9	Environmental Monitoring						
i	Air Quality Monitoring (4 Monitoring stations in project area) twice during construction period	Market Rate	Rs. 7000/sample	56000	56000	----	For Environmental monitoring work separate bid shall be called at local level by TCMC. The scope of this work is not included in main project work.
ii	Noise level Monitoring (at 4 locations including construction sites) six times during construction period	Market Rate	Rs. 1000/sample	24000	24000	----	
iii	Water Quality Monitoring (at Monitoring station per watershed in the project area) twice during construction period (Total No. of Samples at 4 watershed =4*2=8)	Market Rate	Rs.3500/sample	28000	28000	----	
iv	Soil Quality Monitoring (1 stations per watershed of the project area including the silt dumping area, twice during construction period (Total No. of Samples at 4 watershed + 1 dumping area= 4*2+3=11	Market Rate	Rs.3500/Sample	38500	38500	----	
		Total cost for EMP			146500		This cost for EMP is considered in Main Project work.

B	EMP Cost estimate (During Operational Phase)						
9	Lead for disposal of wastes / silt from the drains	cu.m	As per detailed Estimate Vide annexure-15.1			11877570.00	The cost is included in Annual Operation & Maintenance Cost Vide annexure no-15.1. the separate bid shall be called at local level by TCMC. The scope of this work is not included in main project work.
10	Environmental Monitoring						
i	Water Quality Monitoring (at 3 Monitoring stations in the project area) (SW+GW=6) twice after construction period	Market Rate	Rs. 3500/ Sample	42000		42000	
ii	Soil Quality Monitoring (4 stations of the project area + silt dumping area, once after construction period)	Market Rate	Rs. 3500/ Sample	17500		17500	
11	Training programs for the labourers	LS		5,50,000		550000	
12	PPEs for the labourers	LS		4,50,000		450000	
13	Public Awareness and Capacity Building	LS		2,50,000		250000	
C	Environment Consultant for CRZ clearance.	LS		4,50,000		4,50,000	
	Total cost					1,34,37,070	

7.5 SOCIAL IMPACT ASSESSMENT

Social Impact Assessment was carried out with a cut off date of 12.8.2016 and identified about 14 PAFs.

As per the revised/updated SIA for phase-I based on the joint field visit and change in the alignments, design and construction methodology, this sub-project is not involving acquisition of private land, displacement and no R&R is envisaged. Hence this sub project is classified as **S3 category as per ESMF**.

Institutional and Implementation Arrangements

Institutional Arrangements:

The implementation of EMP will be carried out by contractor during construction phase and by Corporation of Thoothukudi during Operation phase. The EMP identified in the EA report will be included in the contract for implementation by the contractor.

Monitoring and Reporting

TCMC will submit periodical compliance report to TNUIFSL along with the progress report with information on the implementation of environmental management measures.

The compliance monitoring will be carried out by TNUIFSL, undertaking periodical site visits during implementation and review of compliance reports.

Grievance Redressal Mechanism:

Two tiers Grievance Redressal Mechanism is proposed one at the project level and second at the Appellate level in addition to the present Grievance Redressal Mechanism. The details are as follows:

A project level grievance redressal committee will be set up and the members are as follows **(preferably one of them as women)**

- The Zonal Officer /Assistant Commissioners of TCMC
- Any one Elected representative
- A social activist from the local area
- Executive Engineer SWD) (Convener)

All the grievances relating to the implementation of Storm water Drainage TCMC phase 1 shall be handled by the Zonal Officers/ Regional Deputy Commissioners of the respective zones of the project area. There will be a participatory approach to include the suggestions, opinions and plans of the affected families address the grievances. The PMC will assist the PAPs to take up any issue that cannot be resolved. The time for resolving the grievances is generally 30 days from receipt of the complaints. The people can submit the grievance in a written form and PMC will assist. The GRC will

meet periodically to dispose of the complaints. People who have disagreement with the outcome may appeal to the Commissioner, who will be appellate authority for this purpose. The composition and contact details of GRC will be notified and widely disseminated among the affected people. TNUIFSL will provide sufficient briefing to the GRC on the ESMF provisions, so that they are in a position to deal with the grievances in line with the ESMF provisions.

The aggrieved person has to contact the project level GRC to air their grievances. The EE is the convener and will convene the meeting as and when required or at frequent intervals in order to resolve the grievances. The proceeding of the meetings will be recorded and minuted. The decision taken on the grievances will be intimated to the aggrieved person. If the aggrieved person is dissatisfied with the decision He/ She can approach the Appellate GRC and get the grievance resolved.

CHAPTER 8 - PROJECT BENEFITS

8.1 ENVIRONMENTAL AND SOCIAL BENEFITS

The population in the project area will be benefited by the implementation of this project with reduction in inundation related issues. Linking to the waterbodies also will improve the water storage and ground water recharge.

The partial/ full relief percentage is about 67 % whereas the percentage as compared to the entire flood points of 146 numbers works out to 38%. With small part out of total cost investment the probable relief will be quite good and hence the Phase I work is proposed to be undertaken on priority.

8.2 ECONOMIC BENEFITS

Direct economic benefits such as the costs for the restoration of damaged roads, engaging earth work excavators, cost of pumping and associated fuel costs, the cost of materials such as sand bags, restoring cross drainages, small bridges etc will be reduced.

Further, the cost of cash and kind relief to flood affected population, loss of live-stock, other structures will be reduced after implementation of SWD Project.

Further, indirect benefits such as improved health status of population due to reduced risk of exposure to water borne diseases such as malaria, dengue and resultant health impacts.

CHAPTER 9 - STAKEHOLDER CONSULTATION AND COMMUNITY PARTICIPATION

9.1 INTRODUCTION

This Stakeholder Consultation presents the result of the analysis of the oral discussions of concern stakeholders in the city of Thoothukudi. This consultation was held after approval of Interim Report and before submission of Draft Final Report of Storm Water Drainage in Thoothukudi Corporation Area. This consultation was planned as per the requirement of TOR.

9.2 OBJECTIVES

The specific objectives of Stakeholders consultation are as follows-

- Collection and dissemination of knowledge
- Improve project design aspects.
- Facilitating the harmonization and setting of standards
- Facilitate development of appropriate and acceptable entitlement options
- Increase long-term project sustainability and ownership;
- Reduce problems for institutional coordination;
- Make the resettlement process transparent; and
- Increase effectiveness of sustainability of income restoration strategies and improve coping mechanisms.

9.3 PROCESS OF STAKEHOLDER CONSULTATION

Prior to the stakeholders meeting letter was circulated in Different Departments of Thoothukudi Municipal Corporation and other departments like National Highways, PWD, and some NGOs were also intimated regarding this meeting.

On the decided venue, date and time, the Consultants carried out the consultations, including focus group discussions with shopkeepers, market association members, and other stakeholders at a number of places. The participants shared their ideas, views to discuss the problems and to come out with solutions. Consultations with local people were conducted in presence of male and female members of different social communities.

Fig 9.1 Invitation to Stakeholders for meeting in Local newspaper



9.4 STAKEHOLDER CONSULTATION AT THOOTHUKUDI

As part of the preparation of Draft Final Report activities for Providing Storm Water Drains for Thoothukudi Municipal Corporation areas, a consultation meeting was arranged at Thoothukudi on 19th September 2016 at 4.00 pm in the corporation marriage hall. The information about the meeting, time and venue were given to all stakeholders well in advance.

A power point presentation was made in local language (Tamil) in order to make them understand about the project, aware of the impacts and also to make them feel free to express their own suggestions and views.

The meeting was chaired by the Honorable Mayor, Thoothukudi City Corporation Mrs. Antony Gracy.

9.4.1 MEMBERS PRESENT

A.P.R. Anthony Grace	Honourable Mayor TCMC.
P. Xavier	Dy. Mayor TCMC.
Mrs. Poongodi Arumaikan	Commissioner TCMC.
Thiru.A.Lakshamanan	Executive Engineer, TCMC.
Smt.Subbulakshami	Assistant Executive Engineer, TCMC.
Mr.Suresh Wagh	Suncon Engineers ,
Mr.Rajendra Magar	Suncon Engineers
Ms.Elamathi	Suncon Engineers
Mr.Sudhakar Wabale	Suncon Engineers
Mr.Ventakesh Garud	Suncon Engineers
Mr. A.Sankar	Executive Director, Empower India, Civil Society Organization. Member of District Consumer Disputes Redressal Forum (Consumer Court)
Mr. K. PonVenkatesh	Jt. Secretary, Indian Chamber of Commerce & Industry.

All AEs of different department of corporation, AEE & AE of PWD Thoothukudi including 121 persons from different categories of social and economical groups were present. Some Councilors, NGOs and other social dignitaries were also attended the meeting.

9.4.2 WELCOME SPEECH

Welcome speech is delivered by The City Engineer, TCMC. He briefed the project preparation and different proposals in his speech. After his speech Honorable Mayor also express her valuable suggestions.

9.4.3 INFORMATION DISSEMINATION

On behalf of consultant, Ms. Elamathi (Social Development Expert) explained the objectives, scope and deliverable's pertaining to the consultancy assignment. She also explained broadly the current status of project, flood situation occurred during the year 2015.

Mrs. Poongodi Arumaikan, Commissioner has also explained broadly on all proposals. The views of stakeholders are also taken into consideration and all the points are incorporated in minutes of meeting.

9.4.4 SUGGESTION FROM THE PARTICIPANT AND ACTION TAKEN

One of the stakeholders suggested to keep proper slope at the time of construction of secondary and tertiary drains. The consultant has design the secondary and tertiary drain with adequate slope. The suggestion given by stakeholder is also noted by Consultant and Commissioner.

One of the stakeholders suggested to provide Rain water harvesting system in residential apartments and societies. The suggestion given by stakeholder is also noted by Consultant and Commissioner.

Most of the stakeholders mentioned that they were affected severely by the inundation during the rains in 2015. They welcomed the project stating that they expect that the flooding would come down with the implementation of the SWD project.

9.4.5 MINUTES OF THE MEETING

MINUTES OF THE MEETING OF THE STAKEHOLDERS MEETING FOR “CONSULTING SERVICES FOR PREPARATION OF DETAILED PROJECT REPORT FOR PROVIDING STORM WATER DRAINS FOR THE THOOTHUKUDI CITY MUNICIPAL CORPORATION (TCMC)” HELD ON 19.09.2016 AT 4.00PM AT CORPORATION MARRIAGE HALL, NEAR SHIVAM TEMPLE, THOOTHUKUDI.

Sr. No.	Name	Designation
1	A.P.R. Anthony Grace	Honourable Mayor TCMC.
2	P. Xavier	Dy. Mayor TCMC.
3	Mrs. Poongodi Arumaikan	Commissioner TCMC.
4	Thiru.A.Lakshamanan	Executive Engineer, TCMC.
5	Smt.Subbulakshami	Assistant Executive Engineer, TCMC.
6	Mr.Suresh Wagh	Suncon Engineers ,
7	Mr.Rajendra Magar	Suncon Engineers
8	Ms.Elamathi	Suncon Engineers
9	Mr.Sudhakar Wabale	Suncon Engineers
10	Mr. A.Sankar	Executive Director, Empower India, Civil Society Organization. Member of District Consumer Disputes Redressal Forum (Consumer Court)
11	Mr. K. PonVenkatesh	Jt. Secretary, Indian Chamber of Commerce & Industry.

All AEs of different department of corporation, AEE & AE of PWD Thoothukudi and 121 persons including Councilors, NGOs and other social dignitaries were attended the meeting.

1. The consultants explained the objectives, scope and deliverables pertaining to the consultancy assignment
2. The total project area is 90.66 Sq. kms which includes the expanded area and the annual rainfall for Thoothukudi is 673mm.
3. The total road length including that of the Highways is 655 kms and the existing drains in the project area is 173 kms.
4. The consultant informed that 10 Permanent benchmarks and 179 Temporary benchmarks have been established.
5. In total 90 trial pits have been done conforming to MoUD

- guidelines for 1*1 Sq.km grid and the total surface water sample analysed
is 5 and groundwater is 5 Nos with 3 silt samples.
6. The rainfall data of 36 years have been collected from IMD and the years of 2008, 2014 and 2015 have seen great flood and the return rainfall intensity for various years have been calculated based on Annual Exceedance series.
 7. The consultant mentioned that rainfall Return period of 2 years for Secondary, Tertiary and Road side drains and 5 years return rainfall intensity for canals/waterways / odai and other primary drains have been adopted for design purpose.
 8. The consultant mentioned that the Topography of Thoothukudi is too flat with maximum elevation of 19 mts and minimum is -1.101 mts below sea level. The maximum high tide level is 0.92 mts and low tide level is -0.05 mts. CMA informed the consultant to obtain the tidal data from authentic sources such as IRS, Anna University.
 9. The consultant mentioned that project area has been bifurcated into 5 catchments namely Upparu River Catchment, Buckle Canal, Mullakkadu, Periapallam Odai and Sub-catchments draining via creek/sea.
 10. The consultant has informed that S.V. Kulam, a major water body in the study area has an area of 52.38 hectares and needs de-silting to enhance the holding capacity and improvement works in surplus weir, bund strengthening etc. while, Old Sankaraperi and Meelavittan lakes are defunct and not in use now.
 11. The consultant mentioned that the recent floods caused is due to the flow from outside catchment area of the project area is draining only to the Buckle canal through Kalangakari Odai, Kalugupathai Odai and Kaluthapathai Odai but Buckle Canal has very low slope and carrying capacity is limited to 15 cum/sec.
 12. The consultant has also mentioned that some low level pockets lie within the old corporation areas and pumping could be the only solution for those areas which has to be finalized after designing the tertiary drains for those areas.
 13. The consultants informed that silt pits will be proposed for every 500 mts for drains of having width of 1 mts and above and Catch pits will also be proposed at every 10 mts for lesser size drains. The consultant was informed to replace the 300 X 300 mts sized drains in the design with Kerb and Gutter arrangements based on feasibility.
 14. Rainwater harvesting shall also to be proposed in all primary and secondary drains at the interval of 500 mts along with necessary silt catch pit at every 30 mtrs based on feasibility. The consultant was requested to include provision of RWH inside the drains greater than size of 1 mts based on soil conditions.
 15. One of the stakeholders suggested to Rain water harvesting in residential apartments and societies, which was agreed by Commissioner.
 16. The consultants suggested the following proposals for effective flood management of the study area after their analysis.
 - a. Diversion of outside catchment flow from Kalangakari Odai, Kalugupathai Odai & Kaluthapathai Odai (On the north-west side of the city) along NH-45B to Periapallam Odai Upto Sea. By this proposal reduction of 1560 ha. Catchment area of Buckle canal will be achieved.
 - b. Diversion of flow of Kalangakari Odai between portion from NH-45B and Meelavittan village to S.V. Kulam and the capacity of S.V. Kulam will also be improved.
 - c. Diversion of flow of Kaluthapathai Odai (between portion NH-45B after the crossing of highway & Pandarmpatti) to S.V. Kulam.

- d. Improvements to S.V.Kulam by increasing the holding capacity, improvements to the bunds and diversion of flow to Buckle canal through Meelavittan road by constructing a new surplus weir in S.V. Kulam.
 - e. Diversion of flow of from Chengulam Odai to Upparu River along NH-45B. This proposal will reduce 2100 Ha catchment area of Buckle Canal.
17. The consultant informed the priority works which needs to be taken up immediately.
- a) Diversion of North side 3 Odais to Periapallam Odai along NH-45B.
 - b) Diversion of Chengulam Odai to Upparu River along NH-45B.
 - c) Diversion of Kalangakari Odai and Kaluthapathai Odai into S.V. Kulam.
 - d) Use of S.V. Kulam as holding pond by de-silting / deepening, repairs / modification of bund / waste weir / outlet arrangement.
 - e) Construction of Channel along Meelavittan Road for S.V. Kulam.
 - f) Widening of Mullakkadu Odai.
18. The consultant informed that Buckle Canal widening is not possible due to longitudinal road development so drain diversion along State Bank colony road would be recommended which ends at sea. Kalangakari Odai (Below S.V.Kulam) flows along railway line which would have to connect to other than Buckle canal. So it is possible to connect to Creek Point after Tiruchandur Road.
19. One of the stakeholder suggested to keep proper slope at the time of construction of secondary and tertiary drains, which was agreed by Consultant and Commissioner.
20. The consultant's proposals have been accepted by TCMC.

Fig 9.2 Photographs of Group Discussion with Stakeholders



9.4.6 PRINT MEDIA NEWS ABOUT THE STAKEHOLDER CONSULTATION

The representatives of concern media were present at the time of stakeholders' consultation. The news published in "The Hindu" news paper dated 20th September 2016.

9.5 PUBLIC DISCLOSURE

After obtaining no-objection to the draft EA report from World Bank, final EA report has been prepared and the final document will be disclosed in the websites of Thoothukudi Corporation and TNUIFSL.

The links are provided below.

TCMC link

www.thoothukudicorporation.com

TNUIFSL link

www.tnuifsl.com

APPENDIX 1

Salient Features of Labour & Environment Protection Laws

SALIENT FEATURES OF SOME MAJOR LABOUR LAWS

APPLICABLE TO ESTABLISHMENTS ENGAGED IN CIVIL CONSTRUCTION WORK

- (a) Employees Compensation Act 1923: The Act provides for compensation in case of injury, disease or death arising out of and during the course of employment.
- (b) 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.
- (c) Employees P.F. and Miscellaneous Provision Act 1952 (since amended): The Act provides for monthly contribution by the employer plus workers @ 10% or 8.33%. The benefits payable under the Act are:
 - (i) Pension or family pension on retirement or death, as the case may be.
 - (ii) Deposit linked insurance on the death in harness of the worker.
 - (iii) Payment of P.F. accumulation on retirement/death etc.
- (d) Maternity Benefit Act 1961: The Act provides for leave and some other benefits to women employees in case of confinement or miscarriage etc.
- (e) Sexual Harassment of Women at the Workplace (Prevention, Prohibition and Redressal) Act, 2013: This Act defines sexual harassment in the workplace, provides for an enquiry procedure in case of complaints and mandates the setting up of an Internal Complaints Committee or a Local Complaints Committee
- (f) Contract Labour (Regulation & Abolition) Act 1970: The Act provides for certain welfare measures to be provided by the Contractor to contract labour 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 license from the designated Officer. The Act is applicable to the establishments or Contractor of Principal Employer if they employ 20 or more contract labour.
- (g) 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 employments.
- (h) Payment of Wages Act 1936: It lays down the mode, manner and by what date the wages are to be paid, what deductions can be made from the wages of the workers.
- (i) Equal Remuneration Act 1976: The Act provides for payment of equal wages for work of equal nature to male and female workers and for not making discrimination against Female employees in the matters of transfers, training and promotions etc.

- (j) Payment of Bonus Act 1965: The Act is applicable to all establishments employing 20 or more employees. Some of the State Governments have reduced this requirement from 20 to 10. The Act provides for payments of annual bonus subject to a minimum of 8.33% of the wages drawn in the relevant year. It applies to skilled or unskilled manual, supervisory, managerial, administrative, technical or clerical work for hire or reward to employees who draw a salary of Rs. 10,000/- per month or less. To be eligible for bonus, the employee should have worked in the establishment for not less than 30 working days in the relevant year. The Act does not apply to certain establishments.
- (k) 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.
- (l) Trade Unions Act 1926: The Act lays down the procedure for registration of trade unions of workmen and employers. The Trade Unions registered under the Act have been given certain immunities from civil and criminal liabilities.
- (m) Child Labour (Prohibition & 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 Labour is prohibited in the Building and Construction Industry.
- (n) Inter-State Migrant workmen's (Regulation of Employment & 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 upto the establishment and back, etc.
- (o) The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996 and the Building and Other Construction Workers Welfare Cess Act, 1996 (BOCWW Cess Act): All the establishments who carry on any building or other construction work and employ 10 or more workers are covered under these Acts. All such establishments are required to pay cess at the 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 accommodations for workers near the work place etc. The Employer to whom the Act applies has to obtain a registration certificate from the Registering Officer appointed by the Government.
- (p) Factories Act 1948: the Act lays down the procedure for approval of plans before setting up a factory engaged in manufacturing processes, health and safety provisions, welfare provisions, working hours, annual earned leave and rendering information regarding accidents or dangerous occurrences to designated authorities. It is applicable to premises employing 10 persons or more with aid of power or 20 or more persons without the aid of power.
- (q) Weekly Holidays Act -1942
- (r) Bonded Labour System (Abolition) Act, 1976: The Act provides for the abolition of bonded labour system with a view to preventing the economic and physical exploitation

of weaker sections of society. Bonded labour covers all forms of forced labour, including that arising out of a loan, debt or advance.

- (s) Employer's Liability Act, 1938: This Act protects workmen who bring suits for damages against employers in case of injuries endured in the course of employment. Such injuries could be on account of negligence on the part of the employer or persons employed by them in maintenance of all machinery, equipment etc. in healthy and sound condition.
- (t) Employees State Insurance Act 1948: The Act provides for certain benefits to insured employees and their families in case of sickness, maternity and disablement arising out of an employment injury. The Act applies to all employees in factories (as defined) or establishments which may be so notified by the appropriate Government. The Act provides for the setting up of an Employees' State Insurance Fund, which is to be administered by the Employees State Insurance Corporation. Contributions to the Fund are paid by the employer and the employee at rates as prescribed by the Central Government. The Act also provides for benefits to dependents of insured persons in case of death as a result of an employment injury.
- (u) The Personal Injuries (Compensation Insurance) Act, 1963: This Act provides for the employer's liability and responsibility to pay compensation to employees where workmen sustain personal injuries in the course of employment.
- (v) Industrial Employment (Standing Order) 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.