ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR COMBINED WATER SUPPLY SCHEME TO SANKARANKOIL, PULIYANKUDI MUNICIPALITIES AND THIRUVENKADAM TOWN PANCHAYAT IN TIRUNELVELI DISTRICT, RAJAPALAYAM, SIVAKASI, THIRUTHANGAL MUNICIPALITES IN VIRUDHUNAGAR DISTRICT WITH RIVER TAMIRABARANI AS SOURCE.

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INTRODUCTION & PROJECT BACKGROUND

Tirunelveli district is located in the southern part of Tamil Nadu. Tirunelveli district has 36 town panchayats and 7 municipalities. Sankarankoil municipality is the second largest municipality in Tirunelveli district. Puliyankudi is a grade II municipality in Tirunelveli district. Thiruvenkadam is a town Panchayat in Tirunelveli and the main occupation of Thiruvenkadam is agriculture.

Virudhunagar district is formerly known as Virudhupatti and it is an administrative district of Tamil Nadu. This district has 7 Municipalities and 9 Town Panchayats. Rajapalayam municipality is a special grade municipality in Virudhunagar district. The economy of the municipality is based on the manufacture of textiles. Thiruthangal is a municipality and this was once a part of Sivakasi.

As the mentioned municipalities and town Panchayat of the two districts are facing severe water problems, Tamil Nadu Water supply and Drainage Board has planned to implement Combined Water Supply Scheme in those water scarce areas.

Existing Water Supply

Sankarankoil Municipality is one the beneficiary of Combined Water Supply Schemes. At present 7.43 MLD of water is being supplied to Sankarankoil Municipality under 3 schemes – (Scheme 1 – 1MLD, Scheme 2 – 2.67MLD, Scheme 3 – 3.2MLD&local source - 0.56 MLD). Puliyankudi municipality is also covered under Combined Water Supply Scheme. At present 4.80MLD of water is being supplied to Puliyankudi Municipality under 2 schemes – (Scheme 1 – 1MLD, Scheme 2- 3.2MLD& local source-0.60 MLD).Thiruvenkadam is a town Panchayat, revenue village in Sankarankoil taluk. Thiruvenkadam is benefitted under Combined Water Supply Scheme and the present water supply of 0.45MLD is being supplied under 2 schemes.

Rajapalayam municipality is supplied with 2.99MLD of water from the existing bore wells and open wells which were executed by TWAD board. It has planned to supply a designed quantity of 8.31MLD under 2 schemes and the total water supply is being supplied 11.30 mld.Combined Water Supply Scheme covers Sivakasi Municipality by having

Tamirabarani River as a source. At present, 5.19 MLD of water is being supplied to Sivakasi Municipality from the following 3 Schemes (Scheme 1 & 2 – 2.19 mld & Scheme 3- 3.00 mld). Thiruthangal municipality isbeing supplied with 4.03 MLD of water under 3 schemes (Scheme 1&2 –2.03MLD, Scheme 3 – 2MLD). The details of the existing water supply is given in **Annexure –I.**

Scope of The Project

As the demand for water gets increasing, there is a need to supply more amount of water than the existing amount. Tamil Nadu Water Supply and Drainage Board have formulated Combined Water Supply Scheme for the present and future requirements of water scarce areas in Tirunelveli and Virudhunagar districts. Water requirement for different periods are given in **Annexure –I.**

Area Name	Prorate Supply (lpcd) (1)	Total Requirement in MLD (Intermediate) (2)	Total Existing Supply in MLD (3)	Balance Requirement in MLD (Intermediate) (2)-(3)
Sankarankoil Municipality	135	10.96	7.43	3.53
Puliyankudi Municipality	135	11.67	4.80	6.87
Thiruvenkadam Town Panchayat	90	1.11	0.45	0.66
Rajapalayam Municipality	135	25.58	11.30	14.28
Sivakasi Municipality	135	13.52	5.19	8.33
Thiruthangal Municipality	135	10.25	4.03	6.22

PROJECT PROPOSAL

This project area comprises of Sankarankoil, Puliankudi Municipalities and Thiruvenkadam Town Panchayat in Tirunelveli District and Rajapalayam, Sivakasi and Thiruthangal Municipalities in Virudhunagar District. The combined water supply scheme is proposed to be implemented under the World Bank assisted Tamil Nadu Sustainable Urban Development Project (TNSUDP).

The water treatment plant of capacity is 46.08 MLD, The water is withdrawn from intake well in Tamirabarani river near Kondanagaram village. The Booster Station I is Manur, Booster Station – II at Panavadalichatram, Booster Station – III at Sankarankoil. The total requirement for this CWSS is 46.08 MLD for intermediate stage (2032) and 61.98 MLD for ultimate stage (2047). Since this much quantity (61.98 MLD) of water is not possible to extract from the sub surface source through infiltration wells, the tapping of surface water is considered by constructing one no of Intake well. The proposed Check dam suggested by PWD is in the downstream side of Palavoor Anaicut and proposed intake well . It is the suitable, nearest and easily accessible location for this Scheme to draw the surface water.

The project will be implemented in two packages as follows

Package I covers construction of Head works, raw water pumping main, Water treatment Plant, Clear water Pumping main, Booster stations at Manur, Panavadali chatram and sankarankovil, Infrastructures to Sankaran kovil municipality, Puliyankudi municipality and Thiruvenkadam town Panchayat in Tirunelveli District.

Package II covers construction of Clear water pumping main, Infrastructures to Rajapalayam Municiality, Sivakasi municipality and Thiruthangal Municipality in Virudhunagar District.

Design Period

Design period is taken as 30 years for this water supply improvement scheme, keeping the base year as 2017. Intermediate design period of 15 years will be from 2017 to 2032 and the ultimate stage will be at 2047.

CATEGORISATION OF PROJECT

The proposed project is classified an **Environmental Categorisation as E1** (water treatment plant, water supply augmentation with new source/ head work/intake works). Hence this project requires detailed Environmental Impact Assessment and preparation of management measures. Based on the **Social Categorisation of Projects,** the number of PAPs in this project is nil, hence this project can be categorized under **S-3 Category.(Ref: Environmental and Social Management Framework (ESMF)**

Approved by the Government of Tamil Nadu vide G.O. (Ms) No.44, Municipal Administration and Water Supply Department, Dated 05.03.2015).

PROJECT DESCRIPTION

Tamil Nadu Water Supply and Drainage Board have proposed to supply water from Tamirabarani River to the areas which are not sustainable during summer and the areas which cannot meet the requirements of water. The areas going to be covered in this project are Sankarankoil, Puliyankudi, Sivakasi, Thiruthangal & Rajapalayam Municipalities and Thiruvenkadam Town Panchayat. This project has proposed to increase the service level of water from 90 lpcd to 135 lpcd in Municipalities and 70 lpcd to 90 lpcd in Town Panchayat.

Salient details of the project components are given below:

- Intake well is located in the Tamirabarani River at Kondanagaram village. Intake well diameter is 8m and pump room diameter is 12.5m.
- Foot Bridge having a width of 3.5m is proposed to be constructed across the river for a length of 112.9m, DI pipes size is 914 x 8mm MS and 9.1m height from the ground level.
- Raw water pumping main of 3.98 km from Intake well to Treatment plant at Kondanagaram.
- Full scale Treatment plant of 46.08 MLD for intermediate stage and 61.98 MLD for ultimate stage.
- Treated water pumping main of length 21.81Km to Booster station I (Manur).
- Pumping main of 22.23 Km Booster station I to Booster station II (Panavadalichatram).
- Pumping main of length 18.01 Km from Booster station II to Booster station III (Sankarankoil).
- Feeder mains to respective ULB sump and then to Service Reservoirs (Existing – 33 Nos & Proposed -22 Nos) and Distribution networks

COST DETAILS

The total cost of the project is Rs. **543.20 Crores.** The base cost/ initial cost of the project is estimated around **380.25 Crores**. The annual maintenance cost is about Rs 10.60 Crores.

SUSTAINABILITY OF THE SOURCE

There are about 134 Water Supply Schemes (Existing 122 nos and 12 nos under progress) in River Tamirabarani and catering the drinking water demands of Tirunelveli, Thoothukudi and Viruthunagar Districts. The total requirement for this CWSS is 46.08 MLD for intermediate stage (2032) and 61.98 MLD for ultimate stage (2047). Since this much quantity (61.98 Mld) of water is not possible to extract from the sub surface source through infiltration wells, the tapping of surface water is considered by constructing one no of Intake well.

The proposed Check dam suggested by PWD is in the downstream side of Palavoor Anaicut and proposed intake well. It is the suitable, nearest and easily accessible location for this Scheme to draw the surface water.

The quantity of water available per year in Tamirabarani river after deducting the quantity required for agriculture and drinking water supply schemes including schemes under progress is about 7075 Mcft. The requirement for this CWSS is only 61.98 MLD (2.19 Mcft for one day, 798 Mcft for one year). The source sustainability of Tamirabarani River detail is given in Annexure IV.

The total balance quantity available in the river Tamirabarani = 6952 Mcft per year

The requirement of this scheme = 798 Mcft per year
(61.98 MLD)

DETAILS OF INTAKE STRUCTURE

The basic function of the intake structure is to help in safety withdrawing water from the source over a predetermined range of pool levels and then to discharge this water into the withdrawal conduit, through which it flows up to the water treatment plant. The Intake Structure design details are given below and in **Figure 2.8.**

1	Pump room design	12m (dia)
2	Drawl pipe diameter	0.7m-3nos(2 Rows)
3	Collection sump	8m(dia) x 14m(d)
4	Depth of Bottom plugging to MWL	14m
5	Depth of Bottom plugging to Normal Flow Level	8.13 m
6	Depth of Bottom plugging to FVL	1.75

Foot Bridge

Foot Bridge is the component in the take structure. It is an appurtenance for maintenance and testing. The foot bridge is supported by 11 centre to centre distance of 10m with total span of 112.9m in which 102.9m is in water and 10m in surface. The level of the hard rail from the average ground level is about 9.1m. The foot bridge is width 3.5m. The Raw water main diameter is 914*8mm MS pipe. The proposed foot bridge diagram is given in **Figure 2.9.**

WATER TREATMENT

Water from Tamirabarani River proceeds with the major treatment process in which dissolved gases are removed and oxidizes dissolved metals such as Iron, Hydrogen Sulphide etc. The treatment systems involved in the CWSS are Aerator**,** Stilling Chamber, Flash Mixing, Clariflocculator, Filtration, clear water sump, Sludge Drying Bed and sludge Drying pit. The treatment plant layout is given in **Figure 2.10.** Chlorination process is not proposed in water treatment, it is proposed in ULBs sumps. `

Future Expansion in Water Treatment Plant

The functional design of WTP has been designed for the intermediate quantity of 46.08 MLD. All units of the proposed WTP are capable of meeting the ultimate stage quantity of 61.98 MLD except Clariflocculator. On account of expansion an additional Clariflocculator would be installed to meet the ultimate stage quantity. The existing land area is sufficient for the future expansion.

BOOSTER STATIONS

There are three booster stations proposed for the project. It is proposed to provide clear water sump of capacity 23.20 LL and sump cum pump house of capacity 2.50 LL in Manur (Booster station – I) and Panavadalichatram (Booster station – II) and clear water sump of capacity 25.70 LLis proposed at Booster station III in Sankarankoil.

SUMPS AND SERVICE RESERVOIRS

The clear water sumps and service reservoir are located in 5 municipalities (Sankarankoil, Puliankudi, Rajapalayam, Sivakasi & Thiruthangal) and one town panchayat (Thiruvenkadam). The number of existing service reservoir is 33 nos and proposed service reservoir is 22 nos. Details of Sumps and service reservoirs are detailed in Section 2.3.5 and 2.3.6

DISTRIBUTION SYSTEM

It is proposed to distribute the water through a distribution network of proposed 492. 7 km and existing 12.7 km pipeline for five Municipalities and one Town Panchayat. The Size and length of distribution system are given in table 2.6.and 2.7.

ALIGNMENT

The alignment of the river bank from Kondanagaram is along roads owned by State High ways, National High Ways, other district highways, and Railway crossing for which permission was applied for a length of approximately 240 km hence no land acquisition is involved. The land adjoining the alignment does not involve forests or any other sensitive areas. Trees 20 Nos will be cut so far during execution. Even though, 200 new plantations will be proposed to be planted at the premise of intermediate booster stations in different locations of the project area.

POWER REQUIREMENT

The total power requirement for pump sets, treatment plant and lights are estimated as 12047.244 MWh.

CONSTRUCTION SCHEDULE

It is programmed to implement the project in 30 months. The works for all the project components would be commenced simultaneously and completed in the specified period.

ENVIRONMENTAL REGULATORY FRAMEWORK

The project has to get source clearance to draw water from the river Tamirabarani. In addition to this, the project would require approval from PWD for headworks and withdrawal, Highways Department, revenue department and Southern Railway for laying transmission mains. It involves railway crossing at 6 locations, National highway crossing at one location and State Highway crossing at 34 locations. The details of locations of crossings are given in **Table 3.1**&**3.2**.

SOURCE CLEARANCE

Approval for the proposal to tap 61.98 MLD of water from River Tamirabarani near Kondanagaram village from Water Utilization Committee of PWD is under process.

S.NO	Activity	Clearance / NOC Required	Statutory Authority	Status
1	Withdrawal of raw water (61.98 MLD) from Tamira barani River	Clearance to be obtained from Water Utilization Committee of PWD for 61.98 MLD for the Ultimate stage Demand.	PWD – Water Utilisation Committee	Proposal Under Scrutiny at CE'S Office/PWD/WRO/ Madurai

BASELINE ENVIRONMENTAL PROFILE

A baseline survey has been conducted in and around the project site from December 2015 to February 2016.

1	Primary data- Collected from field	Water, Noise, Air, Soil, Flora, Fauna, and Social economic
2	Secondary data-refers to data was collected from various Departments	Wind Rose data, Ecology and Benthic data.

Meteorology

Meteorological data was collected during the period (December 2015 to February 2016).

Air Quality

The air quality study show that the maximum average concentration of Particulate matter is found in Rajapalayam and the lowest Pm10 is found in Kondanagaram.. The maximum average concentration of SOx and NOx is found in Rajapalayam (ie.10.2µg/m3 & 22.4µg/m3) and the lowest is found in Kondanagaram (ie.5.6µg/m3 & 11.2µg/m3).

Water Quality

Ground Water Quality in the study area has been analyzed and it is found that the ground water quality in Thiruvenkadam Town Panchayat is worse when compared to other locations in the study area. The surface water quality in Tamirabarani River was analysed and it is foundto be good and potable and can be made available for drinking after surface water treatment.

Noise Quality

The noise quality in the study area is observed and it is found that the maximum noise level is found in Rajapalayam and minimum noise level is found in Kondanagaram.

Soil Quality

The soil quality was assessed in the study area and it is found that the texture classification is Clayey. The soil quality in Rajapalayam is found to be more fertile with high Phosphorous content when compared to other locations of the study area.

Socio Economic

A sample survey has been conducted to collect qualitative information about socio–economic environment of the area. People in Tirunelveli and Virudhunagar districts are engaged in agriculture and also employed in cotton mills, fireworks manufacturing and handloom.

The implementation of CWSS Project will employ (skilled and unskilled) local population within and in the surroundings of the project intervention. This ensures that they will economically benefit from the implementation of the project and as expected, the project will provide up to more than 100 Employment opportunities in Construction Phase and 20-30 Employment opportunities in operation phase.

It expected that all works related to the project will provide a positive increase to the local and national economy in general This will fully contribute to the increase of human socio-economy benefits within and around the project area.

Biological Environment

The major aquatic component of the project area represented by the Tamirabarani River is rich in floral and faunal diversity. The macro faunal composition in the project area is found to have a rich variety of aquatic life.

Aquatic Ecology

Ecological survey was done to understand baseline ecological status, important floristic elements, fauna structure. These species observed studies was carried out in Ambasamundram and Thiruppudaimaruthur. These studies areas are located 10km to 15km distance from Kondanagaram site area. As per baseline studies, there were no endangered, threatened & protected and animal species were recorded in the study area.

ENVIRONMENTAL IMPACT ANALYSIS AND MANAGEMENT PLAN

The impact during the construction and operation phase on land use , topography, surface water, ground water, ambient air quality, noise quality, land environment, traffic, ecology and social aspects have been assessed and management measures have been identified. Impacts will be minimal on account of the proposed mitigation measures.

Laying of pipe line

Laying of Pipe lines is proposed and carried out in the right of way with necessary permissions without causing any environmental disruptions by taking care of precaution measures like air pollution, traffic measures.

In the event of any damaged pipes found in the distribution system will be replaced with high density polyethylene pipes. The damaged pipes will be disposed to TSDF approved by TNPCB and in consultation with Engineer concerned.

Coffer dams will be provided for construction of head work and check dam without any disturbance of river water flow. After completion of work, the coffer dam and other construction debris will be removed, and river bed would be restored. During heavy rain fall and floods when water flows with high velocity, the sluice gates in check dam are kept open.

The noise level of pump sets, motors and other equipment at head works, booster pumping stations will be maintained as per norms for noise level. Suggested adequate noise control measure, In addition to this sufficient trained staffs will be involved to maintain the equipment. Green belt is provided in WTP, booster stations and ULBs sump for reduction of noise level.

Automatic chlorine leak detection and related alarm equipment to be installed at chlorine storage room in ULBs It is connected to a remote audible and visual alarm system and checked on a regular basis to verify proper operation. Maximum 3nos of cylinders will be stored in each Municipalities and town panchayat. Separate storage room provided for full, partial, or empty chlorine cylinders.

Diesel generators will be operated only for emergency power backup. The emission source diesel generators will have adequate stack height as per the norms of CPCB.

For handling the waste water generated onsite during the construction phase provision of septic tank and soak pit for treatment and disposal have been proposed. Control valves would be provided in the inlet of all booster stations, ULB sumps and service reservoirs to control the flow. It can be used to stop the flow until the leakage is rectified. Water meters at pumping stations are used to measure and monitor the flow. In this project, monitoring and controlling the flow in the system will be done with flow control valve with the help of SCADA system.

The backwash water is collected in the recycle sump and the solids allowed settling during one hour detention period. This settled water will be reused for green belt and dust suppression on road works. Drained Water collected from sludge drying bed will be re-circulated with raw water. SCADA system will be provided for monitoring the water treatment plant.

Surge protection arrangements have been provided in the clear water main in order to avoid line bursts to prevent wastage. Rainwater harvesting has been provided in WTP, Booster stations and ULBs sumps for collecting and storing rainwater from rooftops and recharging ground water through pits.

The sludge generated from the Water treatment plant will be dried in sludge drying beds and dry sludge from the treatment plant will be stored in sludge pit and utilized for filing in low laying area.

Around 20 trees have been identified for cutting in the proposed project sites earmarked for ULB sumps and service reservoirs. As a compensatory measure the new plantations will be planted 10 times to the number of trees being cut. Trees will be planted in WTP, booster stations and ULB sumps.

Environmental Management Plan (EMP) during Pre – Construction, Construction and operation Phase is given below.

S. No.	Potential Negative Impacts	Mitigation Measures	Time frame	Responsible agencies
	Pre- Construction			
1	Clearances	All clearance required during construction will be ensured and made available before start of work. Permissions will be obtained from the concerned authority.	Before start of construction	TWAD
2	Tree cutting	Tree cutting activity in the ULB sumps and Service Reservoirs is 20. Compensatory plantation will be 10 times to the number of trees being cut.	During construction	TWAD
3	Utility Relocation	Identify the common utilities to be affected such as: telephone cables, electric cables, electric poles, water pipelines, public water taps etc. Affected utilities will be relocated with prior approval of the concerned agencies before construction starts	Before start of construction	TWAD Board / Contractor
4	Permissions from other departments	State High ways, National High Ways, other district highways, and Railway crossing for which permission was applied for a length of approximately 240 km. PWD approval for the withdrawal of 61.98MLD and pipe carrying bridge will be constructed on length of 112.90mfor river crossing.	Before start of construction	TWAD
5	Design Criteria	All the units of Head Works, treatment plant, ULBs Sumps, booster station and Pump Rooms will be designed in such a way that it can withstand maximum load and without compromising performance. The design will take into consideration all the measures identified.	Before start of construction	TWAD

	During Construction			
1	Baseline parameters	Adequate measures will be taken and checked to control the Baseline parameters of Air, Water and Noise pollution. Base line parameters recorded will be used for monitoring and conformance be ensured.	During Construction	TWAD/Contractor
2	Planning of temporary traffic arrangements	The activities are limited to the project sites and right of way. Hence does not require any traffic arrangements. In case of any need in the site, necessary permissions for temporary diversion will be obtained. Signings and safety measures including flagmen are provided at the site.	During construction	TWAD/Contractor
3	Storage of materials	The contractor will identify site for temporary use of land for construction sites / storage of construction materials, etc.	Before start of construction	Contractor
4	Construction of labour camps	• Contractor will follow all relevant provisions of the Factories Act, 1948 and the Building and the other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 for construction and maintenance of labour camp). • 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. • The contractor will maintain necessary living accommodation and ancillary facilities in functional and hygienic manner and as approved by the Engineer.	During construction	Contractor

		• All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. The sewage system for the camp must be planned. Adequate health care is to be provided for the work force. The layout of the construction camp and details of the facilities provided will be prepared and will be approved by the Engineer. • Awareness about HIV/AIDS will be provided, grievance redressal mechanism for the camps, [only suggestion]		
5	Safety Aspects	• Adequate precautions will be taken to prevent the accidents and from the machineries. All machines used will conform to the relevant Indian standards Code and will be regularly inspected by the TWAD. • Where loose soil is met with, shoring and strutting will be provided to avoid collapse of soil. • Protective footwear and protective goggles to all workers employed on mixing of materials like cement, concrete etc. • Welder's protective eye-shields will be provided to workers' who are engaged in welding works. • Earplugs will be provided to workers exposed to loud noise, and workers working in crushing, compaction, or concrete mixing operation • The contractor will supply all necessary safety appliances such as safety goggles, helmets, safety belts, ear plugs, mask etc to workers and staffs.	During construction	Contractor

		• The contractor will comply with all the precautions as required for ensuring the safety of the workmen as per the International Labour 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 and adhered to. • The contractor will not employ any person below the age of 18 years for any work and no woman will be employed on the work of painting with products containing lead in any form.		
6	Disposal of construction debris and excavated materials	A suitable site identified for safe disposal, in low lying areas within the project area as approved by the Engineer in charge and to other low lying area in consultation with local body.	Pre-construction and Construction	Contractor
7	Barricading site	The activities would be restricted to project sites and right of way for alignment. Barricading with adequate marking, flags, reflectors etc. will be provided along the alignment for safety of restricted traffic movement and pedestrians.	During construction	Contractor
8	Clearing of construction camps and restoration	Contractor to prepare site restoration plans, the plan is to be implemented by the contractor prior to demobilization On completion of the works, all temporary structures will be cleared away, all rubbish cleared, excreta or other disposal pits or trenches filled in and	After completion of Construction	Contractor

		effectively sealed off and the site left clean and tidy, at the contractor's expenses, to the entire satisfaction of the engineer.		
9	Pollution from Fuel and Lubricants	• The contractor will ensure that all construction vehicle parking location, fuel / lubricants storage sites, vehicle, machinery and equipment maintenance and refuelling sites will be located at least 500m from rivers and irrigation canal / ponds • All location and layout plans of such sites will be submitted by the Contractor prior to their establishment and will be approved by the Engineer • Contractor will ensure that all vehicle / machinery and equipment operation, maintenance and refuelling will be carried out in such a fashion that spillage of fuels and lubricants does not contaminate the ground. • Contractor will 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.	During Construction	Contractor
10	Pollution from Construction Wastes	All waste arising from the project is to be disposed off in the manner in consultation with TWAD Engineer	During Construction	Contractor
11	Storage of chemicals and other	Site identified for safe storage and handling of chemicals and other hazardous materials provided with proper display of requirements and marking as protected area.	During Construction	Contractor

	hazardous materials			
12	Informatory signs and Hoardings	The contractor will provide, erect and maintain informatory/ safety signs hoardings written in English and local language, wherever required or as suggested by the Engineer	During Construction	Contractor
13	First Aid	The contractor will arrange for: • A readily available first aid unit including an adequate supply of sterilized dressing materials and appliances as per the Factories Rules in every work zone. • Availability of suitable transport at all times to take injured or sick person(s) to the nearest hospital	During Construction	Contractor
14	Risk from Electrical Equipments	The contractor will take all required precautions to prevent danger from electrical equipment and ensure that- • 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 Standard (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	During Construction	Contractor
15	Waste Disposal	• The contractor will provide garbage bins in the camps and ensure that these are regularly emptied and disposed off in a hygienic	During construction	Contractor

		manner as per the Comprehensive Solid Waste Management Plan approved by the Engineer. • Unless otherwise arranged by local sanitary authority, arrangements for disposal of night soils (human excreta) suitably approved by the local medical health or municipal authorities or as directed by Engineer will have to be provided by the contractor		
16	Environmental Monitoring	The water, air, soil and noise quality will be monitored in pre-construction and Construction phase as detailed in **Table 6.2.**	Pre-construction & Construction	TWAD & Contractor.
17	First Aid	The contractor will arrange for: • A readily available first aid unit including an adequate supply of sterilized dressing materials and appliances as per the Factories Rules in every work zone. • Availability of suitable transport at all times to take injured or sick person(s) to the nearest hospital	During construction	Contractor
18	Rainwater harvesting	Rainwater harvesting arrangements has been provided in WTP, Booster stations and ULBs sumps for collecting and storing rainwater from rooftops and recharging ground water through pits.	Construction Phase	Contractor and TWAD
19	Protection of sites	Compound wall of 2.0 m height shall be provided at all booster station, service reservoirs and WTP for protection.	Construction Phase	Contractor and TWAD
20	Accessibility to sites	Adequate road facilities have been provided in WTP, Booster stations and ULBs sumps for movement of vehicle and unloading of chemicals without disturbing of existing features and activities.	Construction Phase	Contractor and TWAD
	Head Works / WTP/Booster Pumping Station /GLSR/ ESR			

1	Protection of top soil & Environmental enhancing	Top soil from the Head works area will be stored in stock piles and that can be used for gardening purposes at Head works site which will be an environmental enhancing measure	During construction	Contractor
2	Construction of Head work and Check dam	• Coffer dams will be provided for construction of head work and check dam without any disturbance of river water flow. • After completion of work, the coffer dam and other construction debris will be removed, and river bed would be restored. • During heavy rain fall and floods when water flows with high velocity, the sluice gates in check dam are kept open.	During construction	Contractor/ TWAD/ PWD
3	Water treatment plant	• Adequate road facility has been provided inside of treatment plant for movement vehicles and heavy vehicles for unloading of chemical. • Rain water harvesting will be provided for recharging of ground water through pit. • Display boards on safety measures and emergency measures to be installed. • Regular training for the staffs operating the units of WTP with various aspects of maintaining water quality and safety. • Providing equipments like ear plugs to workers near the noise source. • Adequate stack height is given in D.G Set as per CPCB norms.	During construction	TWAD / Contractor.

4	Downstream users (impacts arising due to coffer dams, etc.)	Ensure that the flow stream is not obstructed during construction of coffer dam as directed by Engineer in charge so that there is no impact on the downstream users.	During construction	Contractor
5	Permissions from other departments	Permissions from Southern Railways, National and state Highways, TNPWD, and Revenue Department etc., will be obtained.	During implementation	TWAD
6	Tree plantation	Trees will be grown in the WTP, booster station, and other sump sites etc. Some of the trees are suggested for plantation in above sites, detail is given in **Table 5.6** of the EIA report**.**	During construction	TWAD / Contractor
		Safety in Sites		
7	Additional safety measures	The structures will be provided with easy access ladders, and handrails, interconnections between all units with proper safe walkway platforms for movement to avoid falling of human and materials. Electrical cables are going to be laid in cable trenches. Open spaces at height will be covered with parapet walls and handrails.	During construction	Contractor.
		Construction of Pumping Mains /Transmission Mains		
1	Protection of top soil	The top soil to be protected and compacted after completion of work, where the pipelines run.	During construction	Contractor
2	Laying of pipeline	• Adequate precautions will be taken while laying the water supply mains to avoid the possibility of cross connection with sewer drains. • Pumping main of 900mm diameter will be laid in Tirupanikarisalkulam pond on the right side of the road, it will be laid 2.4 m below ground level ensuring restoration of the existing bed level.	During construction	TWAD/ Contractor

		• Surge protection arrangements have been provided in the clear water main at three locations in order to avoid line bursts to prevent wastage. • Air valve is provided at an interval of 500m in all transmission main to prevent leakage. • Utilities like street light etc. will be relocated without disturbing existing power lines and obtaining prior permission from concerned department. • In the event of any damaged pipes found in the distribution system will be replaced with high density polyethylene pipes. The damaged pipes will be disposed to TSDF approved by TNPCB.		
3	Traffic diversion	• Before taking up of construction activity, a Traffic Control Plan will be devised and implemented to the satisfaction of the Engineer. • Construction will be taken phase-wise so that sections are available for traffic • Temporary diversion will be provided with the approval of the engineer. The Detailed traffic management plans prepared and submitted to the engineers for approval one week prior to commencement of works will 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 arrangements of flagmen. • The arrangement for the temporary diversion of the land will ensure to minimize the environmental impacts like loss of vegetation,	During construction	TWAD / Contractor

		productive lands etc., prior to the finalization of diversion and detours. Special consideration will be given to the preparation of the traffic control plan for safety of pedestrians and workers at night. • The contractor will ensure that the diversion/detour is always maintained in running condition, particularly during the monsoon to avoid disruption to traffic flow. He will inform local community of changes to traffic routes, conditions and pedestrians access arrangements. This plan will be periodically reviewed with respect to site conditions. • The temporary traffic detour will be kept free of dust by frequent application of water.		
4	Temporary flooding due to excavation	Excavation during the laying of mains should be carried out with proper drainage arrangements to avoid the overflowing of existing drains.	During construction	TWAD / Contractor
5	Using of modern machineries	Using of modern machineries such as JCBs, backhoes etc, will be used to minimize the construction period, it will reduce the construction period impacts to the nearby residents	During construction	Contractor
6	Dust pollution near settlements	• All earth work will be protected in manner acceptable to the engineer to minimize generation of dust. Area under construction will be covered & equipped will dust collector. • Construction material will 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	During construction	Contractor

		• Trucks carrying construction material to be adequately covered to avoid the dust pollution and to avoid the material spillage		
7	Protection of residential sensitive receptors	• Noisy construction operations in residential and sensitive areas will 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 in inhabited areas will be installed during the construction phase. • Adequate barricading / other measures to protect dust pollution near sensitive receptors like schools and hospital etc. to be ensured	During construction	Contractor
8	Vehicular noise pollution at residential / sensitive receptors	• 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 500 m away from sensitive receptors. • All possible and practical measures to control noise emissions during drilling will be employed. The TWAD may direct to take adequate controls measures depending on site conditions.	During construction	Contractor
9	Noise from vehicles, plants and equipments	• 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.	During construction	Contractor

		• Maintenance of vehicles, equipment and machinery will be regular and up to the satisfaction of the Engineer to keep noise levels at the minimum.		
10	Storage of construction materials	Site for storage of pipes and construction materials to be identified, without affecting the traffic and other common utilities	During construction	Contractor
11	Pollution from Construction wastes	The Contractor will take all precautionary measures to prevent the wastewater generated during construction (e.g., during the testing of pipeline) from entering into streams, water bodies.	During construction	Contractor
12	Environmental Health and Safety.	EHS guidelines of World Bank will be complied with during construction.	During construction and post-construction	Contractor
IN OPERATION PHASE				
1	Noise Management	• The pumps will adhere to the standards of noise. Regular maintenance will be carried out to restrict the noise levels. • Provided noise control measures and Staffs entering the pump room will be provided with PPEs. • Noise monitoring will be carried out at WTP, booster stations and ULBs sump. • Green belt is provided in WTP, booster stations and ULBs sump for reduction of noise level.	During operation	Contractor/ TWAD

2	Water Management	• Control valves would be provided in the inlet of all booster stations, ULB sumps and service reservoirs to control the flow. It can be used to stop the flow until the leakage is rectified. • Water meters at pumping stations are used to measure and monitor the flow. In this project, monitoring and controlling the flow in the system will be done with flow control valve with the help of SCADA system. • The backwash water is collected in the recycle sump and the solids allowed settling during one hour detention period. This settled water will be reused for green belt and dust suppression on road works. Drained Water collected from sludge drying bed will be re-circulated with raw water. SCADA system will be provided for monitoring the water treatment plant. The details on SCADA system is given in **Chapter 5.4.7**	During operation	TWAD/ Contractor
3	Soil Management	The dry sludge from the treatment plant will be stored in sludge pit and utilized for filing in low laying area in consultation with the Engineer.	During operation	Contractor/TWAD
4	Air Management	• Automatic chlorine leak detection and related alarm equipment to be installed at chlorine storage room in ULBs It is connected to a remote audible and visual alarm system and checked on a regular basis to verify proper operation. • Separate storage room provided for full, partial, or empty chlorine cylinders. • Diesel generators will be operated only for emergency power backup. The emission source diesel generators will have adequate stack height	During operation	Contractor/TWAD

		as per the norms of CPCB and regular maintenance of diesel engines has to be ensured in the Treatment Plan.		
5	Transportation and storage of hazardous chemicals	Guidelines and procedures in Motor vehicle Act 1986 for transportation; Manufacture, Storage and import of Hazardous Chemicals Rules 1989 to be followed for storage and handling of Hazardous chemicals: Insurance covers to be taken for accidents and cost of clean-up operations.	During operation	Contractor
6	Handling of Chemicals	The unit will be provided necessary safety measures for the storage of Alum & Chlorine cylinders and provide emergency repair kit and personal safety kit like full body cover, face mask, body and eye shower etc. at the site. Eye showers one number each will be provided in chlorine cylinder storage place of ULBs (total of 6 Nos). The unit will install Chlorine gas leak detector system (Chlorine Gas Sensor) at the site.	During operation	Contractor
7	Environmental Monitoring	• The water, air noise and soil quality will be monitored periodically. • The water quality will be monitored at various points prior to distribution – head work, treatment plant, clear water sump and booster stations, etc. • Monitoring of noise levels will be carried out at head work, WTP, and booster stations. • Detailed monitoring record will be maintained. Periodical report will be send to the Engineer. The frequency and parameters for Environmental Monitoring detail is given in Table 6.3 of the EIA report.	During operation	TWAD & Contractor.
8	Other Management	• Providing equipments like ear plugs to workers near the noise source.	During operation	TWAD & Contractor

	measures at Sites	• Providing PPEs for safe working of personnel in critical areas like chlorination plant will be ensured. • Display boards on safety measures and emergency measures to be installed. • Regular training for the staffs operating the Head Works with various aspects of maintaining water quality and safety. • PPEs for the workers exposed to high noise. • Regular maintenance of the greenbelt and landscaping made at the project sites with watering, manuring, pruning etc.		
9.	Online Monitoring System through SCADA	Installation of SCADA System for online monitoring at the Head works, Booster stations, ULBs sumps, Service Reservoirs and at the Major tapping points or Branch point and gathering the real time data from remote locations. The details of SCADA is given in Chapter 5.3.7.	Operation Phase	TWAD/Contractor
10	Training for staff	Periodical training would be provided to the staffs and operators involved in the project O&M for chemical handling, emergency, SCADA O&M, line maintenance, valve operations, electrical & mechanical operations, cleaning of sumps and SRs.	During Operation	TWAD / Contractor.
11	O&M Measures	• Rain water harvesting structures, sludge drying pits, Sumps and WTP units shall be cleaned periodically. • Periodically inspection of Pump/motor, Wear ring, impeller and lubrication, alarm systems. • Repair and renewal of Mechanical & electrical equipments, civil works etc.,	During Operation	Contractor/TWAD

12	Water Treatment Plant	• The backwash water is collected in the recycle sump and the solids allowed settling during one hour detention period and will be recirculated into the treatment unit, besides this will also be reused for green belt. • On-line monitoring through SCADA is proposed which would prevent overflow and wastage water. • Dried Sludge will be stored in sludge pit and utilized for filing in low laying area.		

EMP COST

S. No	Description	Amount In Lakhs	Remarks
1)	**HEAD WORKS-**		
A	Coffer Dam including removal of debris	**2.26**	Included in BOQ
2)	**RAW WATER MAIN**		
a)	Restoration of Concrete Road	**1.10**	Included in BOQ
b)	Restoration of Existing pipe (Damaged pipe)	**1.80**	Included in cost estimate
3)	**CLEAR WATER MAIN**		
b)	Restoration of Existing pipe (Damaged pipe)	**6.45**	Included in cost estimate
4)	**TREATMENT PLANT**		
a)	Recirculation Arrangements, sludge drying bed and Sludge Pit	**75.59**	Included in BOQ
b)	Provision for landscaping and greenbelt	**5.00**	Included in BOQ
c)	Development of green belt	**0.20**	Included in BOQ
d)	Construction of Compound Wall around Treatment Plant	**23.50**	Included in BOQ
e)	Septic Tank with Pipe connection works	**0.98**	Included in BOQ
f)	Automation Works (Back wash & Recycling)	**112.56**	Included in BOQ
5)	**Booster Station** at Manur, Panvadalichatram, Sankarankoil, and ULBs Sump At Puliyankudi,Rajapalayam,Sivakasi,Thiruthankal & Thiruvenkadam.		
a)	Construction of Compound wall	**18.20**	Included in BOQ
b)	Greenbelt /Gardening for reducing the noise	**0.12**	Included in BOQ
c)	Chlorine Leak Detection/Alarm eye showers Mask with Cylinder etc at ULB sumps.	**---**	Included in Technical Specification for Chlorinators
6)	**ELEVATED SERVICE RESERVOIRS**		
a)	Construction of Compound wall	**55.80**	Included in BOQ
7)	Distribution System		
b)	Restoration of road surfaces for the proposed Distribution system	**353.48**	Included in BOQ
8)	**Others**		
a)	Provision for shifting of utilities	**---**	Included in project estimate

b)	Disposal of excavated excess earth and construction debris		Included in BOQ
9)	Barricading for Pipe line works including watch and ward showing danger Lights etc		Included in general Specification for Pipe laying works
10)	Rain water Harvesting Structures	**7.71**	Included in BOQ
11)	Online monitoring for efficiency in the project and management of resources through SCADA	**421.00**	Included in BOQ
12)	Monitoring as per Table 6.2 & 6.3		Included in O&M cost estimate
13)	Energy Efficient Lightings		Included in BOQ

Social impact Assessment

The proposed project envisages combined water supply to Sankarankoil, Puliyankudi, Sivakasi, Thiruthangal & Rajapalayam Municipalities and Thiruvenkadam Town Panchayat throughout the day with source as River Tamiraparani. All the lands required for the construction and operation of the components of the study are Owned by Local Body or Government Land , doesn't involve acquisition of private land and doesn't have any social impacts, hence the proposed project has been categorized as "S3" as per ESMF of TNSUDP. However, any impacts identified during project implementation will be mitigated as per ESMF social safeguard policy provisions.

PUBLIC CONSULTATION

As per the World Bank policy on access to information and disclosure, the proposed project attracts Public Hearing. The public hearing was arranged by TWAD board. Public Consultation are informed explicitly to the stake holders/beneficiaries concerned in all the municipalities notifying date and time in newspaper, pamphlets, issuing notices door to door and keeping displays etc,.

ULB public Consultation, date and venue

ULB	DATA	VENUE
Sankarankoil	20.08.2016	Municipal council Hall
Puliangudi	04.07.2016	Municipal council Hall
Rajapalayam	10.08.2016	Municipal council Hall
Sivakasi	12.07.2016	Municipal council Hall
Thiruthangal	08.07.2016	Municipal council Hall
Thiruvenkadam	08.07.2016	Community Hall

Out Come

It was evident from the public consultation that the people are eagerly awaiting for the early implementation of the project. The public also expressed their grievances on present water scarcity and assured complete support during the implementation of this much awaited water supply scheme in their respective Municipalities and Town panchayat.

IMPLEMENTATION AND INSTITUTIONAL ARRANGEMENTS

This project will be implemented on by TWAD under the scheme of Tamil Nadu Sustainable Urban Development Project (TNSUDP). The proposed project involves engagement of prospective contractors during construction and operation phases. The management measures identified for contractor will be included in the bid document. Implementation of the management measures by the contractor will be ensured by TWAD Board and report on ESMF compliance will be submitted to TNUIFSL periodically along with progress report.

GRIEVANCE REDRESSAL MECHANISM:

The TWAD Board will have Grievance Redressal mechanisms to handle the grievances of the project. A project level grievance Redressal committee will be set up and the members are as follows (preferably one of them as women)

1. Executive Engineer (Projects –TWAD Board)
2. Commissioner (For respective Urban Local Body)
3. A person who is publicly known in the local area

PROJECT BENEFITS

Existing Municipality WSS are not dependable for further requirement in the proposed areas. During the summer season, local sources are also depleted hence has been proposed to step up the service level to 135 lpcd taking into account of proposed Under Ground Sewerage Scheme (UGSS). The proposed project is an innovative and demand-driven approach to improve the water supply in the study area. Hence the implementation of this project will definitely assure improved access to water in the water scarce area.

1. INTRODUCTION

1.1 PREAMBLE

Tamil Nadu Water Supply and Drainage Board (TWAD Board) is a statutory body formed by Government of Tamil Nadu. It is responsible for the implementation of providing water supply and sewerage facilities to the public of the entire state of Tamil Nadu except Chennai Metropolitan Area. The activities of TWAD board will be guided and monitored by the Board of Directors of senior level administrators and engineers of Government of Tamil Nadu. At present TWAD Board is maintaining 538 Combined Water Supply Schemes involving 6 Corporations, 58 Municipalities, 288 Town Panchayats, 28,156 rural habitations and 406 Industries/Institutions and 3 government owned water supply projects.

1.2 PROFILE OF THE STUDY AREA

The Combined Water Supply Scheme was initially designed to provide water to Sankarankoil, Puliyankudi and Rajapalayam municipalities by TWAD board, but it was requested to include the nearby highly water scarce municipalities Sivakasi and Thiruthangal to the scheme. The local body represented to rectify the water scarcity in the Thiruvenkadam Town Panchayat with new source. Necessary concurrence has been given by the DTP and also by the Local Body for taking up the investigation works through TWAD Board.

<u>Tirunelveli District</u>

Sankarankoil –It is the second largest municipality in Tirunelveli district. It is 56Km away from Tirunelveli city. Sankarankoil is home to the famous Sankara Narayanan temple. According to 2011 census, this municipality had a total population of 1, 02,406 including 50,780 males and 51,626 females. Agriculture is the main occupation of the town. Apart from agricultural business, this town is well known for textiles. Sankarankoil is categorized under over exploited block based on the assessment of dynamic ground water resources. Block cotton soil is found here and jasmine flowers are largely manufactured in Sankarankoil.

Puliyankudi –Puliyankudi is a grade-II municipal town located between Kadayanallur and Rajapalayam on the National Highway 208. It is 85Km away from Tirunelveli city. According to 2011 census, Puliyankudi had a total population of 66,034 including 32,843 males and 33,191 females. The main occupation in this municipality is agriculture and famous for lemon market. Puliyankudi is also called 'Lemon City'.

Thiruvenkadam –It is a town Panchayat in Tirunelveli district. According to 2011 census, this town Panchayat had a population of 8,337 of which 4,144 are males and 4,193 are females. Thiruvenkadam Town Panchayat has total administration over 2868 houses to which it supply basic amenities like water and sewerage. The main occupation of this town Panchayat is agriculture.

Virudhunagar District

Rajapalayam Municipality –It is a special grade municipality in Virudhunagar district. Its main attractions are Ayyanar falls and the neighbour town Srivilliputtur. The economy of the municipality is based on the manufacture of textiles. It is also famous for the Rajapalayam breed of dogs. Rajapalayam is categorized as over exploited block based on the assessment of dynamic ground water resources. The climate of the region is semi-arid tropical monsoon type and the temperature ranges from 20°C to 37°C. According to 2011 census, Rajapalayam had a population of 1,30,442 with a sex ratio of 1014 females for every 1000 males.

Sivakasi Municipality –Sivakasi is a town and municipality in Virudhunagar district. This town is famous for fire crackers, match boxes and printing industries. Sivakasi has a dry weather, making it suitable for dry crops like cotton, chillies and millets. The topography is almost plain and the soil types found are black and red. The temperature ranges from a maximum of 39 °C to a minimum of 23 °C. The months from April to June are the hottest and December to January are the coldest. Sivakasi receives scanty rainfall with an average of 812 mm annually, which is lesser than the state average of 1,008 mm. According to 2011 census, sivakasi had a population of 2,30,505 including 1,14,321 males and 1,16,184 females.

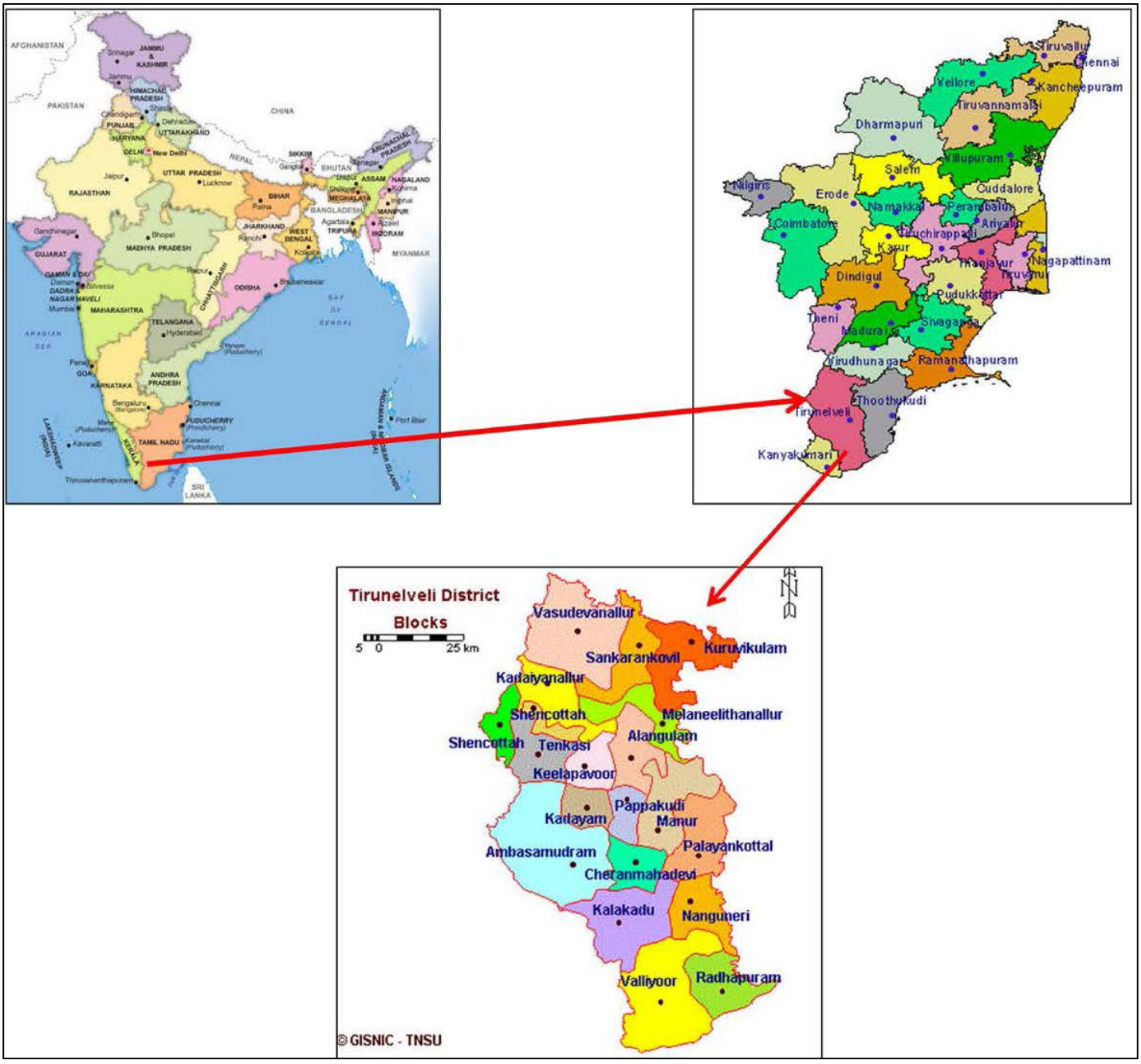


Figure 1. 1: Location Map of Tirunelveli District

Thiruthangal Municipality – Thiruthangal is a municipality in Virudhunagar district. This was once a part of sivakasi and the main occupation of this municipality is manufacturing fire crackers and match boxes. It is 2 km away from sivakasi and Thiruthangal is well connected by bus and train. According to 2011 census, Thiruthangal had a population of 55,343 with a sex-ratio of 1,000 females for every 1,000 males, much above the national average of 929.

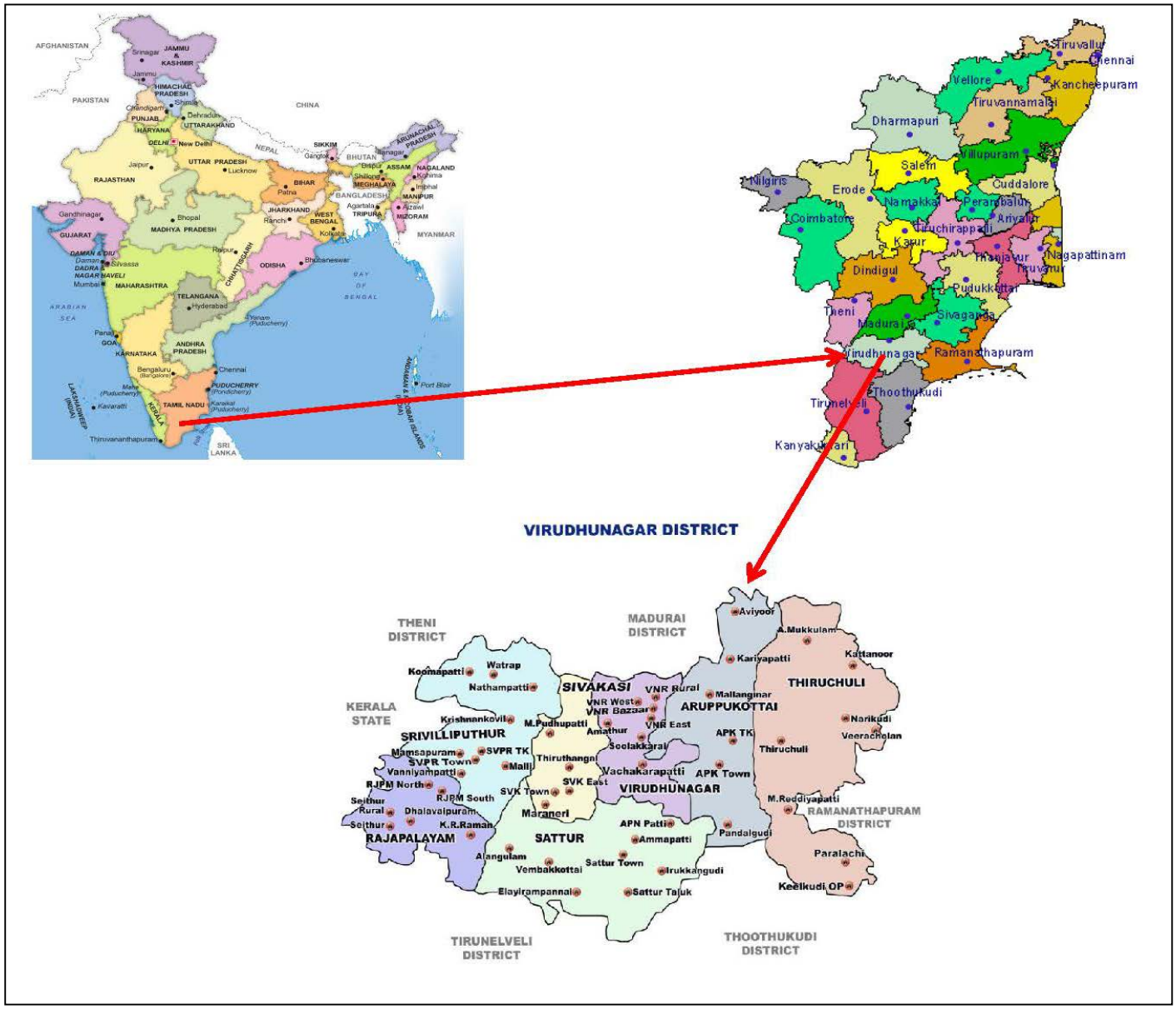


Figure 1. 2: Location Map of Virudhunagar District

1.3 EXISTING WATER SUPPLY

The project area comprises of Sankarankoil, Puliyankudi Municipalities and Thiruvenkadam Town Panchayat in Tirunelveli District and Rajapalayam, Sivakasi and Thiruthangal Municipalities in Virudhunagar District. The existing water supply schemes of the study area are as follows:

- **Sankarankoil Municipality** is one the beneficiary of Combined Water Supply Schemes, at present 7.43MLD of water is being supplied to Sankarankoil Municipality under 3 schemes – (Scheme 1 – 1MLD, Scheme 2 – 2.67MLD, Scheme 3 – 3.2MLD& local source - 0.56 MLD).
- **Puliyankudi municipality** is also covered under Combined Water Supply Scheme. At present 4.80MLD of water is being supplied to Puliyankudi Municipality under 2 schemes – (Scheme 1 – 1MLD, Scheme 2- 3.2MLD& local source - 0.60 MLD).
- **Thiruvenkadam** is a town Panchayat, revenue village in Sankarankoil taluk.Thiruvenkadam is benefitted under Combined Water Supply Scheme and the present water supply of 0.45MLD is being supplied under 2 schemes (Scheme 1 – 0.38MLD,&local source - 0.07 MLD).
- **Rajapalayam** municipality is supplied with 2.99MLD of water from the existing bore wells and open wells which were executed by TWAD board. The designed quantity of 8.31 MLD is being supplied under two schemes and the total water supply is being supplied 11.30 MLD.

Combined Water Supply Scheme covers **Sivakasi** Municipality by having Tamirabarani River as a source. At present 5.19MLD of water is being supplied to Sivakasi Municipality under 2 schemes – (Scheme 1 – 3.00MLD, & local source – 2.19 MLD).

Thiruthangal municipality is being supplied with 4.03MLD of water under 2 schemes (Scheme 1 – 2.00MLD, &local source – 2.03 MLD). Existing Water supply details are given in **Annexure I**.

Table 1. 1: Existing Water Supply System

Area Name	Prorata Supply (lpcd) (1)	Total Requirement in MLD (Intermediate) (2)	Total Existing Supply in MLD (3)	Balance Requirement in MLD (Intermediate) (2)-(3)
Sankarankoil Municipality	135	10.96	7.43	3.53
Puliyankudi Municipality	135	11.67	4.80	6.87
Thiruvenkadam Town Panchayat	90	1.11	0.45	0.66
Rajapalayam Municipality	135	25.58	11.30	14.28
Sivakasi Municipality	135	13.52	5.19	8.33
Thiruthangal Municipality	135	10.25	4.03	6.22

1.4 SCOPE OF THE PROJECT

Tamil Nadu Water Supply and Drainage Board have been carrying out many water supply schemes to supply water to water scarce areas. The purpose of this project is to supply water from Tamirabarani River to the areas which are not sustainable during summer and the areas which cannot meet the requirements of water. The areas covered under this project are Sankarankoil (Municipality), Puliyankudi (Municipality) & Thiruvenkadam (Town Panchayat) of Tirunelveli districts and Sivakasi (Municipality), Thiruthangal (Municipality) & Rajapalayam (Municipality) of Virudhunagar district. This project has proposed to increase the service level of water from 90 lpcd to 135 lpcd in Municipalities and 70 lpcd to 90 lpcd in Town Panchayat. The local body represented to rectify the water scarcity in the town Panchayat with new source. **Annexure - I** shows the water requirement designed for various periods.

1.5 NEED FOR THE PROJECT

The demand for water in the future is one of the key issues in water supply planning. Sankarankoil, Puliyankudi and Thiruvenkadam of Tirunelveli district and

Rajapalayam, Sivakasi and Thiruthangal of Virudhunagar district are facing water shortage problems mainly during summer. During summer, the water level in the available resources of these places become very low and it cannot meet the needs of people. Therefore, it is proposed to provide CWSS to 5 Municipalities and 1 Town Panchayat in Tirunelveli and Virudhunagar district. The proposed CWSS would be implemented under the World Bank assisted Tamil Nadu Sustainable Urban Development Project (TNSUDP).

1.6 PROJECT PROPOSAL

This project area comprises of Sankarankoil, Puliankudi Municipalities and Thiruvenkadam Town Panchayat in Tirunelveli District and Rajapalayam, Sivakasi and Thiruthangal Municipalities in Virudhunagar District.

Head Works and Water Treatment Plant are proposed to be located at Kondanagaram village, Tirunelveli district. The withdrawal of water from intake well is located in Tamirabarani River, near Kondanagaram village. The raw water Pumping main is 3.98 km length and 914 mm x 8.00 mm thick MS pipes. The water treatment plant is capacity of 46.08 MLD. The water collected in the clear water sump of 23.20 LL capacity and sump cum pump house of 2.50 LL capacity will be pumped to the proposed clear water sump of 23.20 LL capacity and sump cum pump house of 2.50 LL capacity @ Manur (Intermediate Booster Station I) through 914 mm x 8.00 mm thick MS pipes of 21.81 km length and then pumped to the clear water sump of 23.20 LL capacity and sump cum pump house of 2.50 LL capacity proposed at Panavadalichatram (Intermediate Booster Station II) through 914 mm x 8.00 mm thick MS pipes of 22.23 km length. From there, water will be pumped to clear water sump of 25.70 LL capacity (Intermediate Booster Station III) at Sankarankoil through the pumping main of 914 mm x 8.00 mm thick MS pipes of 18.01 km length. From this sump, water will be pumped to the five Municipalities and one Town Panchayat through 4 pumping mains.

The total requirement for this CWSS is 46.08 MLD for intermediate stage (2032) and 61.98 MLD for ultimate stage (2047). Since this much quantity (61.98 MLD) of water is not possible to extract from the sub surface source through infiltration wells, the tapping of surface water is considered by constructing one number of Intake well.

The proposed Check dam suggested by PWD is in the downstream side of Palavoor Anaicut and proposed intake well. It is the suitable, nearest and easily accessible location for this Scheme to draw the surface water.

The project will be implemented in two packages as follows

Package I covers construction of Head works, Raw water pumping main, Water treatment Plant, Clear water Pumping main, Booster stations at Manur, Panavadali chatram and sankarankovil, Infrastructures to Sankaran kovil municipality, Puliyankudi municipality and Thiruvenkadam town Panchayat in Tirunelveli District.

Package II covers construction of Clear water pumping main, Infrastructures to Rajapalayam Municiality, Sivakasi municipality and Thiruthangal Municipality in Virudhunagar District.

1.6.1 Population Forecasts & Demand Projections

Adopting enhanced prorate supply of 135 lpcd for Municipalities and 90 lpcd for Town Panchayat with 10 % transmission loss and 5% treatment loss, the requirement of water is calculated as given in **Table 1.2.** The design detail is given in **Table 1.3.**

Table 1. 2: Water Requirement Designed for Various Periods

S. No	Name of Municipality/ Town Panchayat	Population			Pro rata supply in lpcd	Total Requirement including fire demand in MLD		Existing supply in MLD	Balance Requirement in MLD	
		Base year 2017	Intermediate 2032	Ultimate 2047		Intermediate 2032	Ultimate 2047		Intermediate 2032	Ultimate 2047
1	Sankarankoil Municipality	63000	77000	95000	135	10.96	13.39	7.43	3.53	5.96
2	Puliyankudi Municipality	72000	82000	98000	135	11.67	13.83	4.80	6.87	9.03
3	Rajapalayam Municipality	150000	180000	215000	135	25.58	30.11	11.30	14.28	19.01
4	Sivakasi Municipality	80000	95000	112000	135	13.52	15.81	5.19	8.33	10.62
5	Thiruthangal Municipality	61000	72000	86000	135	10.25	12.14	4.03	6.22	8.11

6	Thiruvenkadam Town Panchayat	9150	11550	14560	90	1.11	1.38	0.45	0.66	0.93
	Total	435150	517550	620560		73.09	86.86	33.20	39.89	53.66
	Raw water Requirement including transmission loss 10% and wash water loss 5 % MLD)								**46.08**	**61.98**

1.6.2 Design Period

Design period is taken as 30 years for this water supply improvement scheme, keeping the base year as 2017. Intermediate design period of 15 years will be from 2017 to 2032 and the ultimate stage will be at 2047.

Table 1. 3: Design Details

1)	Design Period	30 Years
2)	Method of Population projection (a) Sankarankoil (b) Puliyankudi (c) Rajapalayam (d) Sivakasi (e) Thiruthangal (f) Thiruvenkadam	 Semi log method Semi log method Semi log method Semi log method Semi log method Geometric increase method
3)	Rates of supply	Municipality – 135 lpcd Town Panchayat – 90 lpcd
4)	Water losses	15%
5)	Friction coefficient	DI Pipe : 140PVC Pipe: 145
6)	Pipe method	As per pipe policy of TWAD Board.
7)	Detention time (a) Sump (b) Pumping hour	 60 minutes 23 hours
8)	Capacity of Service Reservoir	1/3 of the Intermediate population
9)	Residual head 12m staging height of SR(E) 16m staging height of SR(P)	 Maximum:22, Minimum:7 Maximum:22, Minimum:12

1.7 CATEGORISATION OF PROJECT

The proposed project is classified as **Environmental Categorisation as E1** (water treatment plant, water supply augmentation with new source/ head work/intake works). Hence this project requires detailed Environmental Impact Assessment and

preparation of management measures. **Social Categorisation of Projects,** the number of PAPs in this project is nil, hence this project can be categorized under **S-3 category.**

TNUIFSL is promoting the following principles of Environmental & Social sustainable infrastructure projects. The TWAD board implementing comprehensive water supply schemes and follow the TNUIFSL principles.

a) Environmental sustainability by minimizing release of polluting wastes, ensuring quality life in urban environment, conserving natural resources, preserving bio-diversity and ecological equilibrium; and integrating mechanisms within projects to maintain and enhance environmental quality of project locations.

b) Social relevance by

- Addressing legitimate concerns of relevant stakeholders, especially project affected persons irrespective of their legal rights.
- Avoiding or minimizing resettlement and rehabilitation due to land acquisition and transfer of government land under different tenure system through appropriate technical and management measures.
- Ensuring appropriate resettlement and rehabilitation of project affected persons irrespective of legal status with a view to provide sustainable livelihood options that enable the affected people to improve or at least restore their standard of living in the post impact period.
- Protecting marginalized and vulnerable groups, including the economically and socially disadvantaged people through additional support and
- Minimizing health and safety hazards.

1.8 STRUCTURE OF THE REPORT

The structure of the EIA report is given below:

Chapter 1 – Introduction
Chapter 2 – Project Description
Chapter 3 – Environmental Regulatory Framework
Chapter 4 – Baseline Environmental Profile
Chapter 5 – Environmental Impact Analysis
Chapter 6 – Environmental Management Plan
Chapter 7 – Public Consultation
Chapter 8 –Implementation and Institutional Arrangements
Chapter 9 – Project Benefits
Chapter10 - Conclusion

2.0 PROJECT DESCRIPTION

2.1 Introduction

Tamil Nadu Water Supply and Drainage Board have proposed to supply water from Tamirabarani River to the areas which are not sustainable during summer and the areas which cannot meet the requirements of water. The areas going to be covered in this project are Sankarankoil, Puliyankudi, Sivakasi, Thiruthangal& Rajapalayam Municipalities and Thiruvenkadam Town Panchayat. This project has proposed to increase the service level of water from 90 lpcd to 135 lpcd in Municipalities and 70 lpcd to 90 lpcd in Town Panchayat.

The proposed project involves the construction of intake well in Tamirabarani River at Kondanagaram on the upstream side of the proposed check dam to be constructed by PWD. The water quality is found to be good and potable; it is then treated in water treatment plant at Kondanagaram to make it more acceptable and specific to end use like drinking, it is pumped with the help of 3 booster stations and then taken to Service Reservoirs through distribution networks connecting them.

The project location is given in **Figure 2.1.** The location of the intake well, water treatment plant, booster station I, II and III are given in **Figure 2.2, 2.3, 2.4, 2.5 and 2.6.** The flow diagram of CWSS is given **Figure in 2.7.** The land ownership details are given in **Annexure III.**

Salient details of the project components are given below:

- Intake well is located in the Tamirabarani River at Kondanagaram village. Intake well diameter is 8m and pump room diameter is 12.5m.
- Foot Bridge having a width of 3.5m is proposed to be constructed across the river for a length of 112.9m, DI pipes size is 914 x 8mm MS and 9.1m height from the ground level.
- Raw water pumping main of 3.98 km from Intake well to Treatment plant at Kondanagaram.
- Full scale Treatment plant of 46.08 MLD for intermediate stage and 61.98 MLD for ultimate stage.
- Treated water pumping main of length 21.81Km to Booster station I (Manur).
- Pumping main of 22.23 Km Booster station I to Booster station II (Panavadalichatram).

- Pumping main of length 18.01 Km from Booster station II to Booster station III (Sankarankoil).
- Feeder mains to respective ULB sump and then to Service Reservoirs (Existing – 33 Nos & Proposed -22 Nos) and Distribution networks.

Figure 2. 1-Project Location

Figure 2. 2-Location of Intake Well at Kondanagaram

Figure 2. 3-Location of Water Treatment Plant at Kondanagaram

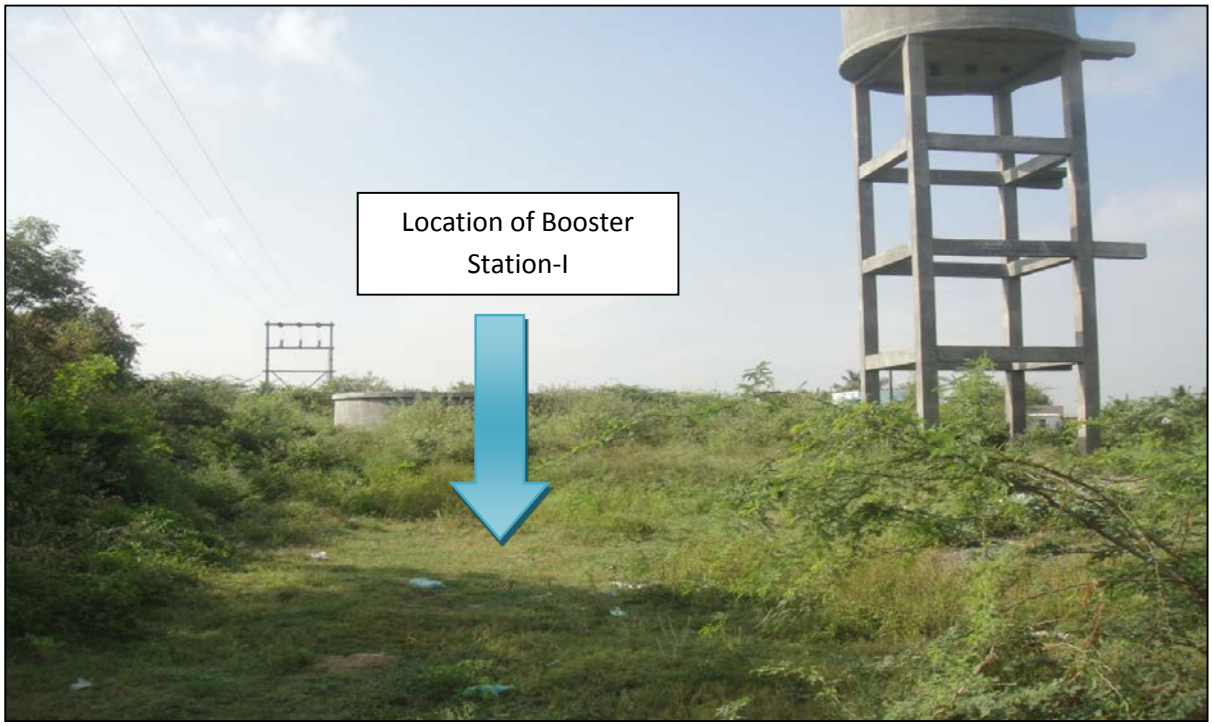


Figure 2. 4-Location of Booster Station – I at Manur

Figure 2. 5-Location of Booster Station – II at Panavadalichatram

Figure 2. 6-Location of Booster Station – III at Sankarankoil

2.2 Cost Details

The total cost of the project is Rs. **543.20 Crores.** The base cost/ initial cost of the project is estimated around **380.25 Crores**. The annual maintenance cost is about Rs 10.60 Crores. The detailed project cost detailed given in **Table 2.1.**

Table 2. 1– Cost Details

Sl.No	Beneficiaries	Base cost + Annual Maintenance cost -5 Years (In Crores)
1	Sankarankoil Municipality	51.79
2	Puliyankudi Municipality	84.45
3	Rajapalayam Municipality	192.54
4	Sivakasi Municipality	114.33
5	Thiruthangal Municipality	87.60
6	Thiruvenkadam Town Panchayat	12.50
Total Project cost		**543.20**

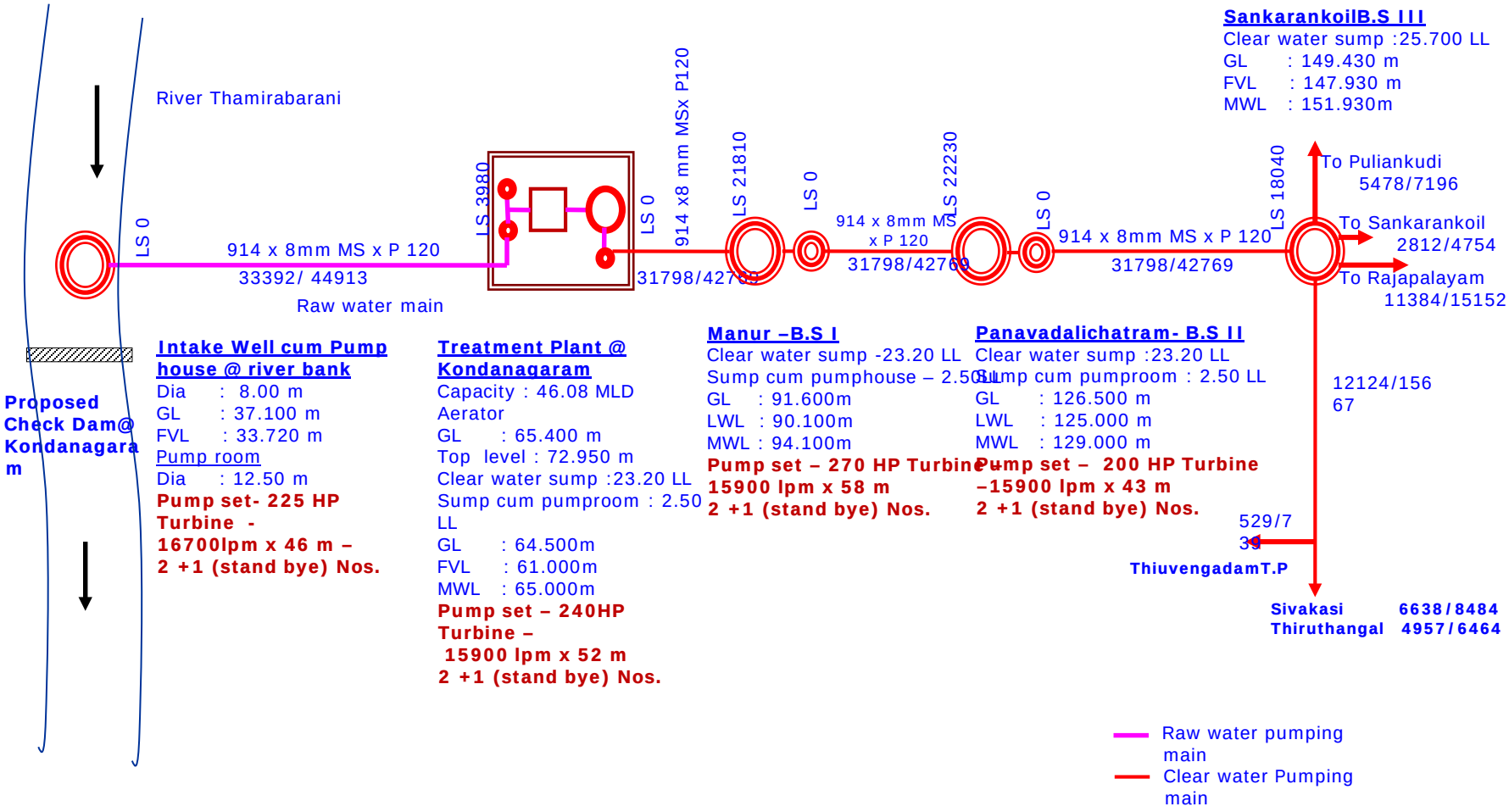


Figure 2. 7– Flow Diagram of CWSS

2.3 Components of the project

2.3.1 Head Work

The required quantity of water for intermediate and ultimate stage from Tamirabarani River is 46.08 and 61.98 MLD respectively. Since there is no pollution in the upstream side, it is proposed to draw water from the intake well and pumped to the water treatment plant through the pumping main made of Mild Steel (914 mm x 8mm thick) for a length of 3.98Km from Tamirabarani River on the upstream side of the proposed check dam to be constructed by PWD.

The proposed check dam will be constructed at a distance of 100m from the downstream side of the intake well and downstream of existing Pazhavoor Anicut in Tamirabarani River near Kondanagaram village.

2.3.1.1 Sustainability of the source

The Tamirabarani River originates from the famous Agastyarkoodam peak of Pothigai hills of the Western Ghats, above Papanasam in the Ambasamudram taluk, and traverses about 128 km through Tirunelveli and Thoothukudi Districtsof Tamil Nadu. The Total River basin area is 5969 sq.km of which 688 Sq.km is in hilly tract. The average rainfall in the Ghats section is more than 2000 mm, whereas in the plains it is around 850 mm.

There are about 134 Water Supply Schemes (Existing 122 nos and 12 nos under progress) in River Tamirabarani, catering the drinking water demands of Tirunelveli, Thoothukudi and Viruthunagar Districts. The requirement for this CWSS is 46.08 MLD for intermediate stage (2032) and 61.98 MLD for ultimate stage (2047).Since this much quantity (61.98 MLD) of water is not possible to extract from the sub surface source through infiltration wells, the tapping of surface water is considered by constructing one no of Intake well.

The proposed Check dam suggested by PWD is in the downstream side of Palavoor Anaicut and proposed intake well. It is the suitable, nearest and easily accessible location for this Scheme to draw the surface water.

By analyzing water released Data of Papanasam and Manimuthar dams for 27 years and the flow details of Palavoor anaicut, it is inferred that the quantity of water available per year in Tamirabarani River after deducting the quantity required for agriculture and drinking water supply schemes including schemes under progress is about 7075 Mcft. The requirement for this CWSS is only 61.98 MLD (2.19 Mcft for one day, 798 Mcft for one year).

The total balance quantity available in the river Tamirabarani =6952 Mcft per year

The requirement of this scheme = 798 Mcft per year

= 61.98 MLD

Hence the quantity required for the above CWSS can be safely met out from the river Tamirabarani under normal seasonal condition near the proposed Check dam suggested by PWD which is in the downstream side of Palavoor Anaicut and proposed intake well.

The sustainability of the source is given in **Annexure – IV.**

2.3.1.2 Intakes for collecting surface water

The basic function of the intake structure is to help in safety withdrawing water from the source over a predetermined range of pool levels and then to discharge this water into the withdrawal conduit, through which it flows up to the water treatment plant. In case of a reservoir where gravity flow is possible, the water may be directly taken through the conduit up to the treatment plant, whereas in this case of direct river supplies the water after entering the intake well may have to be lifted by low lift pump and then to the treatment plant through conduits. The intake well is given in **Figure 2.8**. The intake structure design details given in **Table 2.2.**

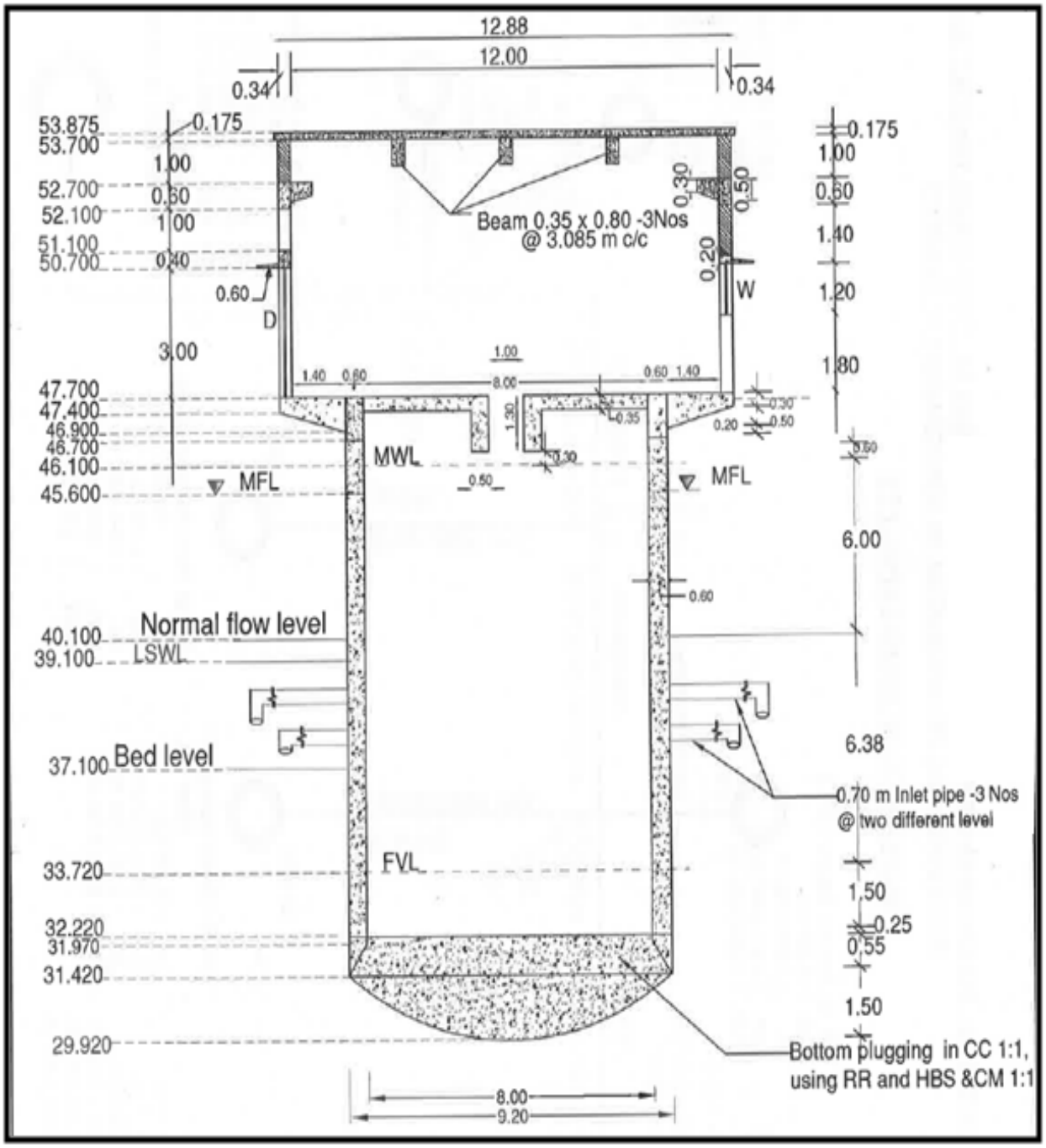


Figure 2. 8-Structure of Intake well

Table 2. 2–Design details of intake structure

1	Pump room design	12m (dia)
2	Drawl pipe diameter	0.7m-3nos (2 Rows)
3	Collection sump	8m(dia) x 14m(d)
4	Depth of Bottom plugging to MWL	14m
5	Depth of Bottom plugging to Normal Flow Level	8.13 m
6	Depth of Bottom plugging to FVL	1.75

2.3.1.3 Foot Bridge

Foot Bridge is the component in the take structure. It is an appurtenance for maintenance and testing. The foot bridge is supported by 11 centre to centre distance of 10m with total span of 112.9m in which 102.9m is in water and 10m in surface. The level of the hard rail from the average ground level is about 9.1m. The foot bridge is width 3.5m. The Raw water main diameter is 914*8mm MS pipe. The proposed foot bridge diagram is given in **Figure 2.9.**

2.3.1.4 Water quality of Tamirabarani River

The Tamirabarani water is cannot be used directly for drinking purpose because of the presence of high turbidity, TSS and biological pollutants. The water treatment is required for removal of the physical, chemical and biological contaminate from river water. The Tamirabarani river water quality is given in **Table 2.3.**

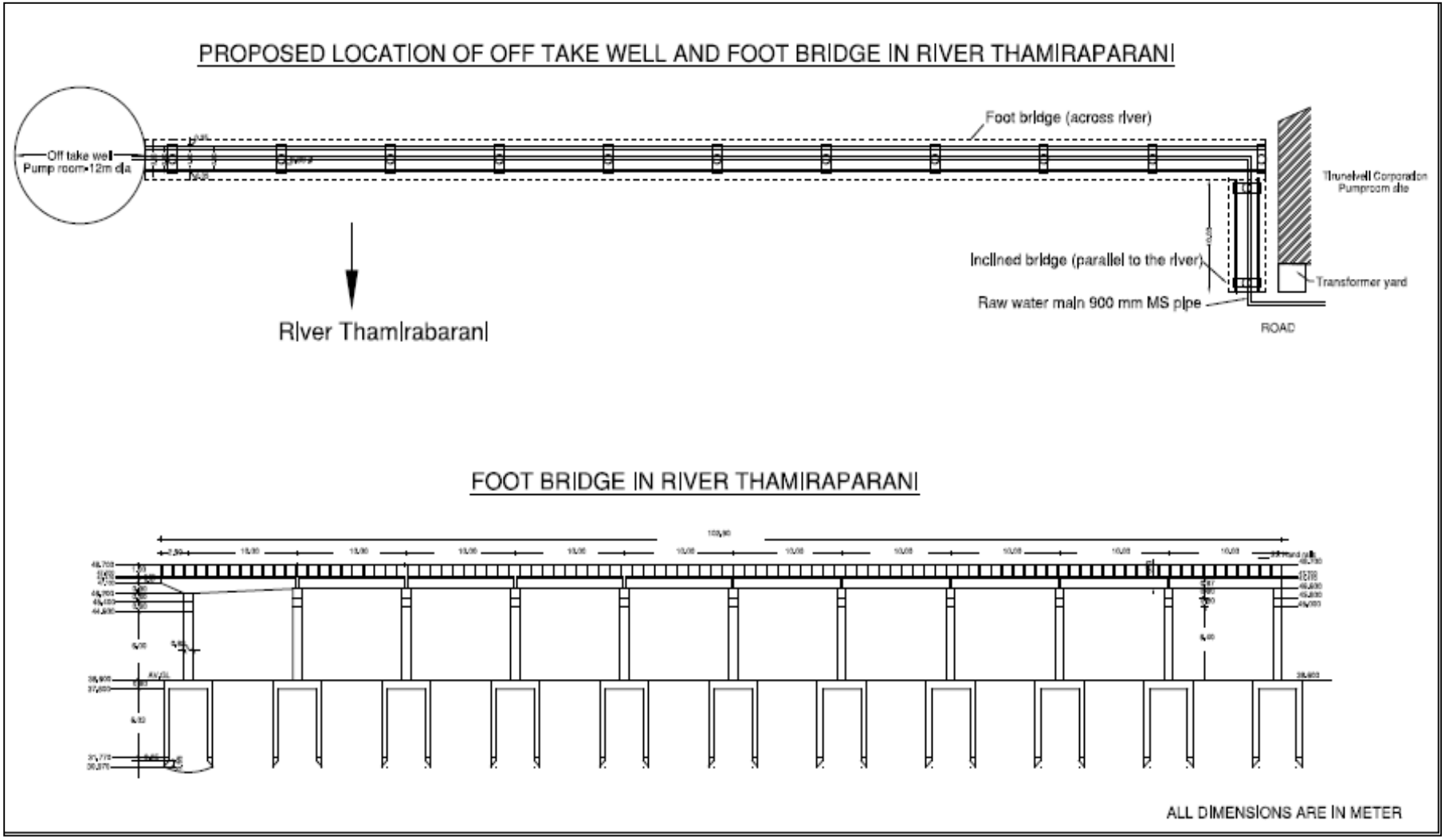


Figure 2. 9-Proposed Foot Bridge in Tamirabarani River

Table 2. 3–Tamirabarani River Water Chacteristics

2.3.2

TEST WATER BEFORE TASTE

TAMIL NADU WATER SUPPLY & DRAINAGE BOARD
DISTRICT WATER TESTING LABORATORY,
Seevalperi road ,Santhi nagar,Palayamkottai -627002 - Ph:0462-2542576

From
P.Gopalan, B.Sc.,
Junior Water Analyst,
TWAD Board, DWT Lab,
Tirunelveli-2.

To
The Assistant Executive Engineer,
TWAD Board,
PF Sub.division .1,
Tirunelveli.

Lr No 43574/TWAD/DWTLab/TNY/2015-16/ Dt.30.11.2015

Sir,

Sub : Examination of Water Sample report -furnished - reg.
Ref : 1. Your Lr.No.23/11F. Rajapalayam CWSS/AEE1/PF/Tly/dt.23.11.2015
2. T.O Invoice No.7071/dt.23.11.2015 for Rs. 500/-

The result of analysis for the water sample sent under reference is furnished below.

Scheme : 43574 : CWSS to Sankarankoil,Puliyangudi,Rajapalayam,Sivakasi,Thiruthangal and Thiruvengadam TP.

Source : 43574 : Raw Water - Intake Well — Date of Collection : 23.11.2015
Location: 43574 : Head Work at Kondanagaram. — Date of Receipt : 23.11.2015

Sample Collected by : Er.V.Ramalakshmi, Asst. Engr. P.F Sub.divn, Tirunelveli.

BIS 10500 : 2012 I. PHYSICAL EXAMINATION.	Acceptable limit	Permissible limit in the absence of alternate source	Result - 43574
1. Appearance	-	_	Clear
2. Colour (pt.co-scale)	5	15	Colourless
3. Odour	Agreeable	Agreeable	None
4. Turbidity NT Units	1	5	13
5. Total dissolved Solids mg/L	500	2000	160
6. Electrical Conductivity Micro mho/cm	-	-	235
II.CHEMICAL EXAMINATION:			
7. pH	6.5-8.5	6.5-8.5	7.20
8. Ph. Alkalinity as $CaCo_{3\ mg/L}$	-	-	0
9. Total Alkalinity. as $CaCo_{3\ mg/L}$	200	600	90
10. Total Hardness as $CaCo_{3\ mg/L}$	200	600	104
11. Calcium as Ca mg/L	75	200	20
12. Magnesium as Mg mg/L	30	100	13
13. Sodium as Na mg/L	_	_	6
14. Potassium as K mg/L	_	_	2
15. Iron as Fe mg/L	0.3	0.3	0.24
16. Manganese mg/L	0.1	0.3	0.00
17. Free Ammonia as $NH_{3\ mg/L}$	0.5	0.5	0.32
18. Nitrite as $NO_{2\ mg/L}$	-	-	0.07
19. Nitrate as $NO_{3\ mg/L}$	45	45	2
20. Chloride as Cl mg/L	250	1000	15
21. Fluoride as F mg/L	1.0	1.5	0.0
22. Sulphate as $SO_{4\ mg/L}$	200	400	9
23. Phosphate as $PO_{4\ mg/L}$	-	-	0.19
24. Tidys Test 4 hrs.as $O_{2\ mg/L}$	-	-	0.24

Report: 43574 : The given water sample is Chemically Potable.

Water Treatment Plant

A full scale treatment plant of capacity 46.08 MLD with conventional rapid sand filter method will be provided in the enroute of Kondanagaram – Thiruppanikarisalkulam rural

road in S.F.No. 536 of Kondanagaram village. The classification of treatment plant site is Meikkal Promboke land and having an extent of area 6.0 Hectare 10.5 Ares. The treatment plant layout, water treatment process and schematic diagram of water treatment are given in **Figure 2.10, 2.11 and 2.12.** The water treatment plant components detail is given in **Annexure II.**

2.3.2.1 Water Treatment Process:

Water from Tamirabarani River proceeds with the major treatment process in which dissolved gases are removed and oxidizes dissolved metals such as Iron, Hydrogen Sulphide etc.

(a) Aerator

Aeration brings water and air in close contact in order to remove dissolved gases (such as carbon dioxide) and oxidizes dissolved metals such as iron, hydrogen sulphide, and volatile organic chemicals. The Cascade Aerator will be used, tray is 5 Nos and diameter is 13.20m.

(b) Stilling Chamber

The water after passing through Aerator enters the stilling chamber to remove the air bubbles. It is maintaining the flow velocity. The detention time is 1.5 min and dimension is 6m length X 4.5m width X 3m depth.The raw water measuring channel flow rate is 0.533m^3/sec, flow velocity is 0.3 m/sec and dimension is 11 m length X 2.4m width X 1.75 m Depth. The dividing chamber detection time 45 sec, over all depth 4.9m and diameter is 3.0m.

(c) Flash Mixing

- Water is then taken into the Flash Mixer for intimate mixing of chemicals with the raw water.
- The raw water is dosed with Alum and Lime to coagulate and flocculate the suspended / colloidal matter and form flock of higher nuclei.

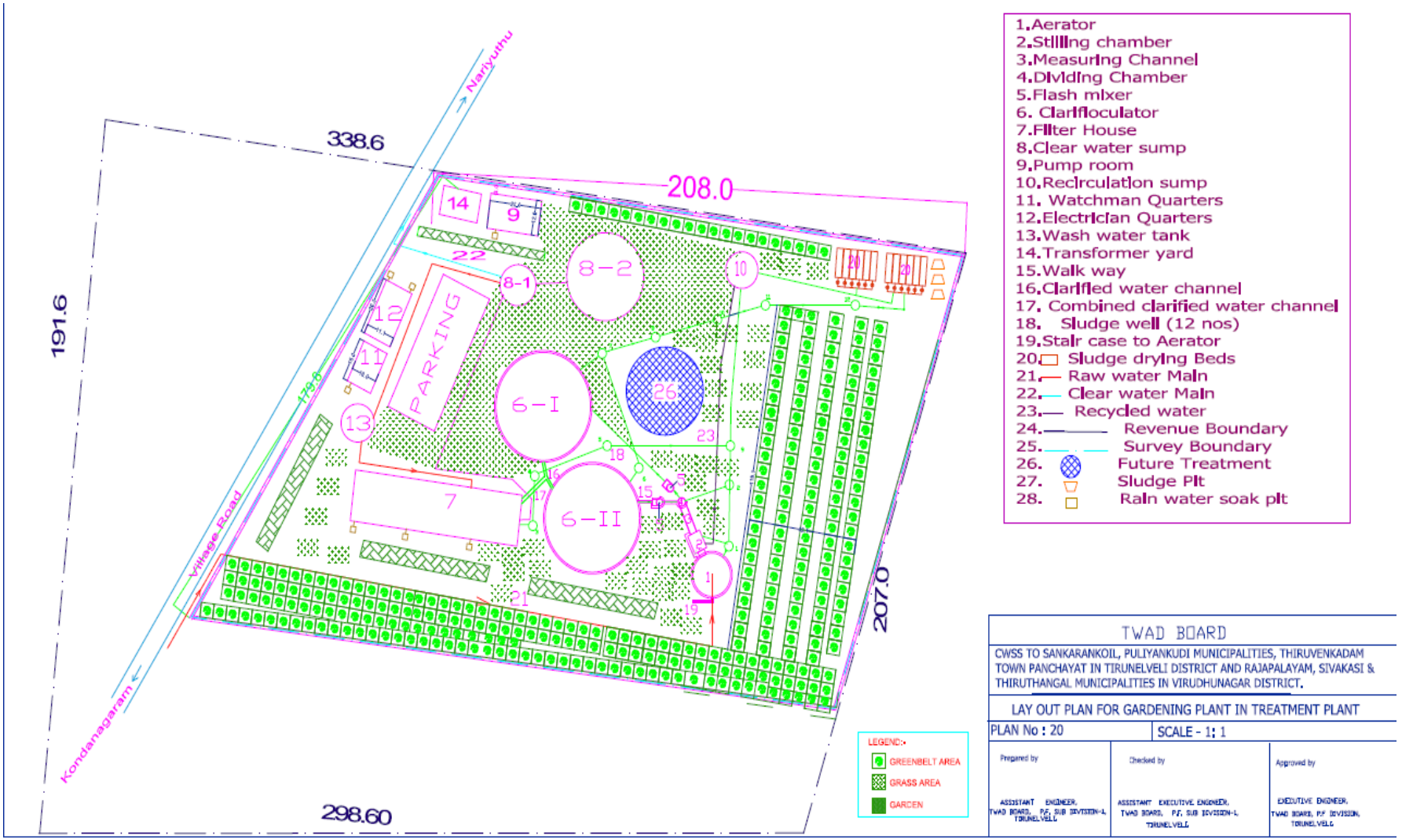


Figure 2. 10-Treatment Plant Orientation Plan

It is proposed to provide 2Nos. of Flash Mixers adopting detection times of 60 sec, diameter is 2.3m and over all depth is 4.45m. A vertical type 3.00HP electric motor with suitable provisions for variable speed rotation 100 to 200 RPM with scour pipe of 300-mm dia CI Pipe.

(d) Clariflocculator

- Chemically dosed raw water is then fed into the Clari-flocculator unit wherein flocculation and clarification of raw water takes place.
- Clarification is the separation from water of heavier suspended particles by gravitational settling. Efficient clarification preceding filtration permits larger filter runs and help to reduce filter runs and helps to reduce filter problems such as cracking and mud ball formation.

It is proposed to provide 2nos. of Clariflocculator. It comprises of both flocculator and clarifier compartment. In as much as the permissible flow enlarged diameter of inlet pipe 900-mm, velocity is up to 0.80 m/sec. provide a diameter13.5m with 3.0 m depth of Water column for the Flocculation Basin. The inlet velocity of Clarifier is 0.3m/min and diameter of 36m.

(e) Filtration

Filtration acts as the removal of suspended matter, bacteria, viruses and protozoa. The accumulated residue is removed during the backwash process. Backwash water may be heavily polluted with a wide range of pathogenic micro-organisms and chemicals. Untreated and un-disinfected backwash wastewater must never come into direct contact with people. The filter media comprises 0.75 m depth of sand bed under laid by support media of 0.450 m graded gravel. The filter structure should have adequate depth to provide 1.2 to 1.50m. The depth of gravel bed ranges from 40 to 60 cm. The depth of filter bed is 2.9m. Wash water application is 600 lpm / m^2 (ie 0.60 m^3 / min /m^2) for 10 minutes so as to wash two filter at a time without refilling. (ie 0.60 m^3 / min /m^2). The filter cum and chemical house dimension is 65.4m X 17.2m.

(f) Disinfection

Disinfection aims in reducing Disinfection is the process of selectively destroying or inactivating pathogenic organisms present in water usually by chemical means. Disinfection aims in reducing the organisms in water to such low levels that no infection of disease result when the water is used for domestic consumption including drinking. Chlorine cylinder used for the disinfection process. Chlorination is not proposed for Water Treatment Plant since the consumer point is far away from the WTP location (60 -120 km), and hence proposed only in ULBs sumps.

(g) Sludge Drying Bed

The sludge from stilling chamber and clarifier will be sent to the sludge drying bed. Sludge drying bed (SDB) is the most widely used method for sludge dewatering.

The most commonly used equations for predicting the quantity of alum or iron coagulant sludge are

$$S= Q*(0.44AI+SS+A)$$

Where
S= Sludge Produced Q=Plant Flow, (m^3/day); AI=Liquid Alum Dose (mg/l);
SS=Raw Water Suspended Solids (mg/l)
A= Net Solid from Additional Chemical Added Such as Polymer (mg/l)

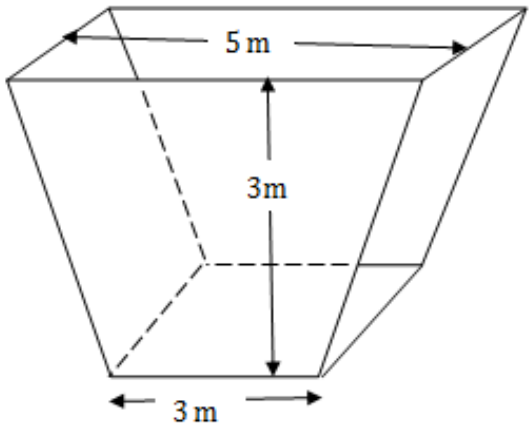
$$S = 46.08x10^6(0.44x50 +10 mg/l) / (1000*1000) = 1475kg \text{ dry solids}$$

The maximum amount of sludge generation in monsoon season is 1474 kg/day. During normal season only,1/3 (492 kg/day) of sludge will be generated. The sludge drying beds of 12 Nos are of size 10mX2.5mX0.25m (each) with a sludge storage period of 1 day.

(h) Sludge Pit

Sludge from the Water treatment plant is proposed to be dried in the sludge drying beds, the dried sludge is proposed to be disposed in sludge container pit inside the water treatment plant remise away from working units. Water from sludge drying bed is collected in re-circulation sump and water will be sent to the raw water distribution chamber for recycling.

3 Numbers of Trapezoidal Sludge pit with dimension at top 5mx5m, bottom 3mx3m and depth is 3m, of volume is 50m^3(each) and with smooth HDPE Geomembrane as impervious lining material for sludge pit for protection of sub grade from percolation of water through sludge deposit. Each pit requires a cleaning period of 2 months.



WATER TREATMENT PROCESS

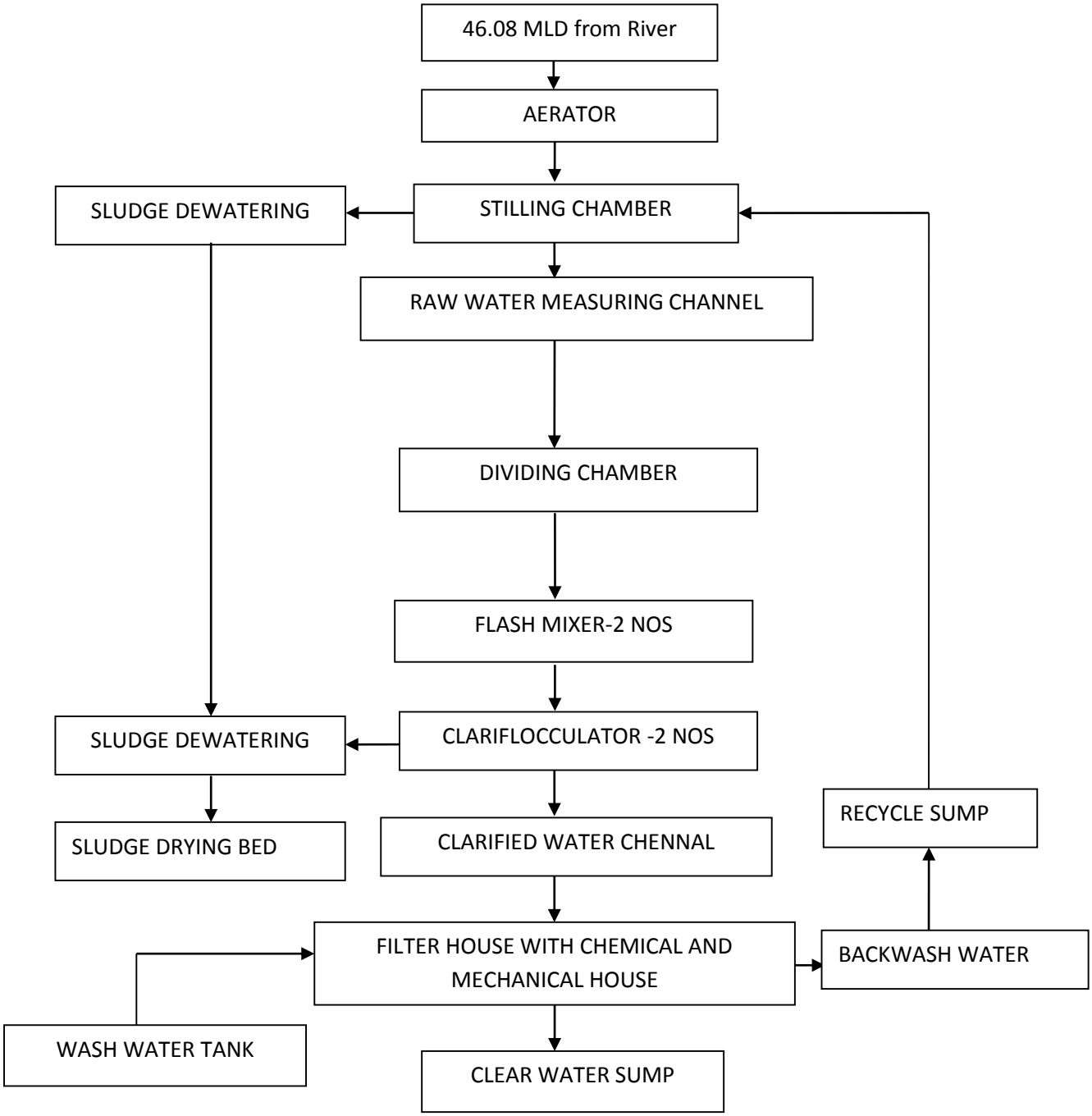


Figure 2. 11-Water Treatment process Flow Diagram

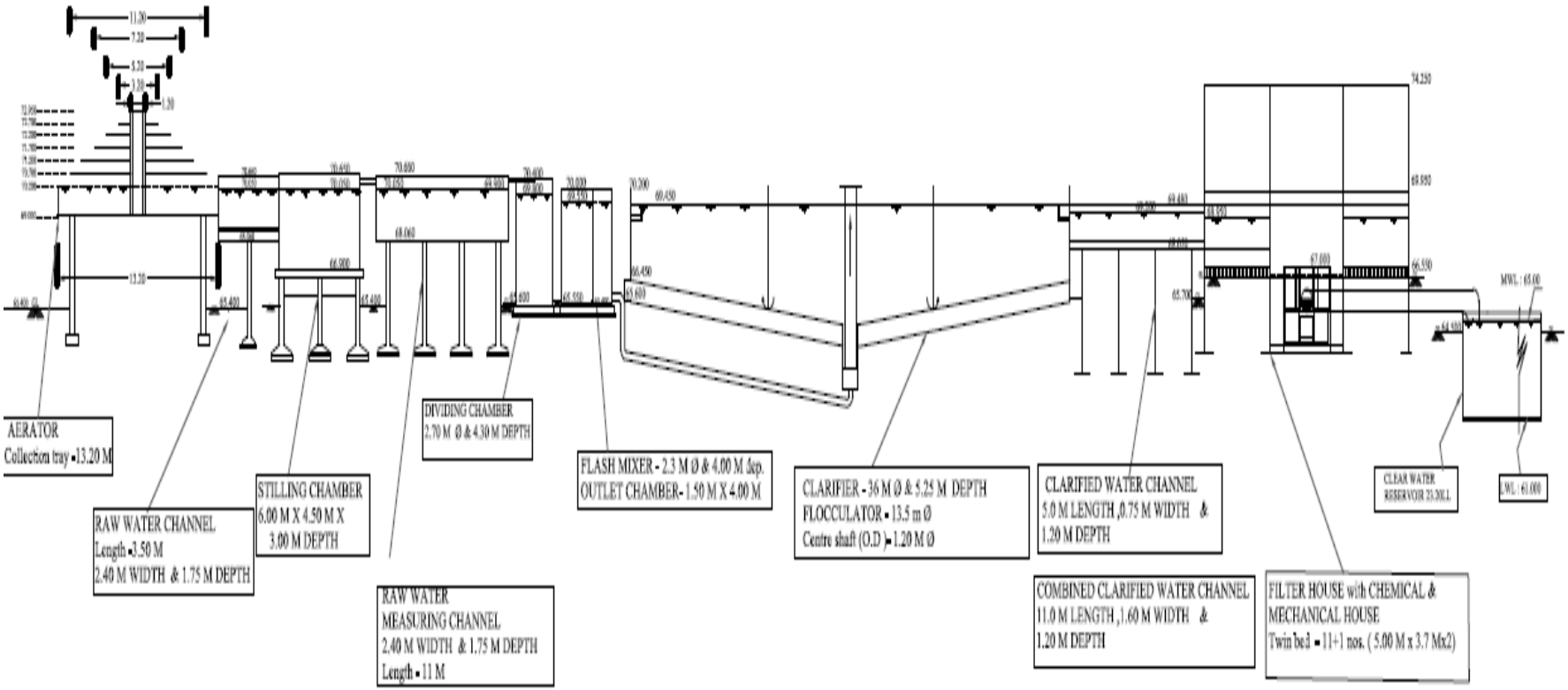


Figure 2. 12-Schematic diagram of Water Treatment

Treated water Quality

The water treatment plant treated water quality would be maintained in as per is ***IS10500:2012*** standard*.* The treated water quality characteristic is given in **Table 2.4**.

Table 2. 4– Treated Water Quality Characteristics

S.No	*Parameter*	*Requirement desirable limits IS10500:2012*
1	Colour	5
2	Turbidity (NTU)	10
3	pH	6.5 to 8.5
4	Total hardness (mg/l)	300
5	Calcium (mg/l)	75
6	Chloride (mg/l)	250
7	Sulphates (mg/l)	150
8	Nitrate (mg/l)	45
9	Iron (mg/l)	0.3
10	Magnesium as Mg (mg/l)	30
11	Zinc (mg/l)	5.0
12	Lead (mg/l)	0.1
13	Fluoride (mg/l)	0.6 to 1.2

2.3.2.2 Future Expansion in Water Treatment Plant

The functional design of WTP has been designed for the intermediate quantity of 46.08 MLD. All units of the proposed WTP are capable of meeting the ultimate stage quantity of 61.98 MLD expect Clariflocculator. On account of expansion an additional Clariflocculator would be installed to meet the ultimate stage quantity. The existing land area is sufficient for the future expansion.

2.3.3 Booster Stations

There are three booster stations proposed for the project. The FMB sketch for all the Booster stations and ULBs sumps are enclosed in **Annexure VI.**

Booster Station I at Manur

It is proposed to provide clear water sump of capacity 23.20 LL and sump cum pump house of capacity 2.50 LL in Manur, the enroute of Rajapalayam-Tirunelveli State

Highways SH 41 road at S.F.No. 256 of Manur village. The land classification comes in Mayanam Poromboke and the area required for the booster station is 0.60 acres.

a) Booster station II at Panavadalichatram

It is proposed to provide an intermediate Booster station in Panavadalichatram at S.F.No 885/14 of Vadakku Panavadali Village. It is proposed to provide clear water sump of capacity 23.20 LL and sump cum pump house of capacity 2.50 LL. The area required for the booster station is 0.60 acres.

b) **Booster station III at Sankarankoil**

It is proposed to provide another intermediate Booster station at Sankarankoil near the existing Booster station and 8.00 LL service reservoirs constructed under Manur CWSS. The land is Municipal land and the area required is 1.50 acres. It is proposed to provide clear water sump of capacity 25.70 LL and 2Nos of pump room of size 15m x 9mto house the HSC pump sets.

2.3.4 Pumping Main

Raw water mains from head works to treatment plant and clear water mains from Treatment plant to Booster stations and Booster stations to service reservoirs are designed for 23 hours of pumping.

The alignment of pumping main which takes water from Tamirabarani River is 914mm x 8mm thick MS pipe and runs about 3.980 Km along Kondanagaram rural road. The water collected in the clear water sump in the WTP will be pumped to the proposed Booster station – I at Manur and then pumped to the clear water sump and sump cum pump house at Panavadalichatram (Intermediate Booster Station –II) and then water will be pumped to clear water sump at Sankarankoil (Intermediate Booster Station – III).The alignment of pumping main is along Kondanagaram – Thiruppanikarisalkulam – Nariyuthu – Rastha rural road and Rajapalayam – Sankarankoil – Tirunelveli state Highways road (SH41) up to Manur. This pumping main of 914mm x 8 mm thickness extends up to 21.81 km.

The alignment of pumping main from Booster station I at Manur to Booster station II at Panavadalichatram is along Rajapalayam – Sankarankoil – Tirunelveli state Highways

road (SH 41) up to Panavadalichatram.The pumping main runs for a distance of 22.230Km and is made up of 914 mm X 8 mm thick MS pipes.

The alignment of pumping main is along Rajapalayam - Sankarankoil – Tirunelveli SH road (SH 41) from Panavadalichatram to Sankarankoil. The water will be pumped to clear water sump of capacity 25.70 LL through 914 mm X 8 mm thick MS pipes of length 18.01Km.

Branch Pumping main from Booster station III @ Sankarankoil to the Service reservoirs in the ULBs

a) Sankarankoil Municipality:

Capacity of clear water sump	Pumping Mains	Proposed Service Reservoirs	Existing Service Reservoirs	Total length of the feeder main
25.70 LL	Pumping Main I	3	4	5.86 km

b) Puliankudi Municipality:

The required water for Puliankudi Municipalitywill be pumped to the proposed sump at Puliyankudi through pumping main of length 18.865 km and is made of 400 mm DI K9 & K7 pipes.From the sump, water will be pumped to the following service reservoirs.

Capacity of clear water sump	Pumping Mains (Dia: 400 mm)	Proposed Service Reservoirs	Existing Service Reservoirs	Total length of the feeder main
4.35 LL	Pumping Main I	1	1	9.22 km
	Pumping Main II	1	2	
	Pumping Main III	2	2	
	TOTAL	**4**	**5**	

c) Rajapalayam Municipality:

The water required for Rajapalayam Municipality will be pumped to the proposed sump at Rajapalayam through pumping main (600mm DI K7 pipe) of length 33.76Km. From the sump, water will be pumped to the following service reservoirs:

Capacity of clear water sump	Pumping Mains (Dia: 600 mm)	Proposed Service Reservoirs	Existing Service Reservoirs	Total length of the feeder main
9.10 LL	Pumping Main I	2	1	10.51 km
	Pumping Main II	3	1	
	Pumping Main III	5	2	
	TOTAL	**10**	**4**	

The requirement of Sivakasi, Thiruthangal Municipalities and Thiruvenkadam Town Panchayat will be pumped through separate pumping main of 600 / 300 /100 mm DI pipes of length 54.73 Km and collected in 2.65 LL capacity (proposed- integrated with Manur CWSS) sump at Sivakasi, 3.90 LL capacity (proposed) sump at Thiruthangal and 0.65 LL capacity (proposed- integrated with Manur CWSS) sump at Thiruvenkadam Town Panchayat.

d) Sivakasi Municipality:

Capacity of clear water sump	Pumping Mains (Dia: 600 mm)	Proposed Service Reservoirs	Existing Service Reservoirs	Total length of the feeder main
2.65 LL	Pumping Main I	0	3	6.89 km (Existing)
	Pumping Main II	1	1	6.575 km (Proposed)
	Pumping Main III	1	2	
	Pumping Main IV	0	2	
	TOTAL	**2**	**8**	

e) Thiruthangal Municipality:

Capacity of clear water sump	Pumping Mains (Dia: 300 mm)	Proposed Service Reservoirs	Existing Service Reservoirs	Total length of the feeder main
3.90 LL	Pumping Main I	1	3	6.97 km
	Pumping Main II	1	3	
	Pumping Main III	0	1	
	TOTAL	**2**	**7**	

f) Thiruvenkadam Town Panchayat

Capacity of clear water sump	Pumping Mains (Dia: 100 mm)	No. of Service Reservoirs	Proposed Service Reservoirs	Existing Service Reservoirs	Total length of the feeder main
0.65 LL	Pumping Main I	4	1	3	7.265 km
	Pumping Main II	2	0	2	
	TOTAL	**6**	**1**	**5**	

2.3.5 ULB Sumps

Sankarankovil Municipality

It is proposed to pump the requirement of Sankarankovil Municipality from the 25.7 LL sump in booster station III at Sankarankovil.

Puliyankudi Municipality

It is proposed to construct a sump of capacity 4.35 LL to collect the requirement for Puliyankudi Municipality near RSKP.

Rajapalayam Municipality

It is proposed to construct one no of Sump of capacity 9.10 LL at Rajapalayam (Inside the Commissioner Quarters) to collect the requirement of Rajapalayam Municipality. The land is owned by Rajapalayam Municipality.

Sivakasi Municipality

It is proposed to construct a sump of capacity 2.65 LL to collect the requirement of Sivakasi Municipality near the existing sump.

Thiruthangal Municipality

It is proposed to construct a sump of capacity 3.90 LL to collect the requirement Thiruthangal Municipality near the existing sump.

Thiruvenkadam Towm Panchayat

It is proposed to construct a sump of capacity 0.65 LL to collect the requirement Thiruvenkadam Town Panchayat near the existing sump.

2.3.5.1 Chlorination in ULB sumps

Chlorination process is not proposed in water treatment, it is proposed in ULBs sumps. The chlorine cylinder has been provided in the entire municipalities and maximum utilized 3Nos of cylinders. Thiruvenkadam Town Panchayat is proposed 1 No

of Electro chlorinator based common salt arrangements. the details of chlorination process given in **Table 2.5.**

Table 2. 5– Details of Chlorination

SN	Name of Municipality / Town Panchayat	Inter-mediate requirement in lpm	Quantity in m^3/hr	Chlorine requirement in kg / hour adopting 2 ppm	Monthly Requirement in kg for 3 months storage	Monthly Requirement in kg for 1 moths storage	No of cylinders 0.9 mt	Stand Bye	Total
1	Sankarankoil Municipality	2812	168.72	0.34	728.8704	242.9568	1	1	2
2	Puliyankudi Municipality	5478	328.68	0.66	1419.8976	473.2992	1	1	2
3	Rajapalayam Municipality	11384	683.04	1.37	2950.7328	983.5776	2	1	3
4	Sivakasi Municipality	12058	723.48	1.45	3125.4336	1041.8112	2	1	3
5	Thiruthangal Municipality	4957	297.42	0.59	1284.8544	428.2848	1	1	2
6	Thiruvenkadam Town Panchayat	1 No of Electro chlorinator based on common salt arrangements of capacity of 7.30 LL /day is proposed							

2.3.6 Service Reservoirs

The details of proposed and existing service reservoirs of five Municipalities and one Town Panchayat are as follows:

a) <u>Sankarankoil Municipality</u>

There are four number of existing reservoirs are available in SankarankoilMunicipality. They are 8.0 LL service reservoir (2 Nos), 7.00 LL (`1 No.) and 2.00 LL service reservoir (1 No.). It is proposed to construct three number of service reservoirs additionally in the following places as requested by the local body.

- 3.00 LL service reservoir, 16m staging in Ward No.10
- 3.00 LL service reservoir, 16m staging in Barathiyar street
- 3.70 LL service reservoir, 16m staging in Puliyankudi road

b) Puliyankudi Municipality

There are five existing service reservoirs available in PuliyankudiMunicipality. They are 9.0 LL service reservoir (1 No), 10.00 LL (1 No) and 3.00 LL (1 No), and 2.00 LL service reservoirs (2 Nos).Additionally four service reservoirs will be constructed as requested by the local body as follows.

- 4.00 LL service reservoir, 16m staging near Government Hospital
- 4.00 LL service reservoir, 16m staging, in RSKP
- 2.30 LL service reservoir, 16m staging, in Chinthamani
- 0.70 LL service reservoir, 16m staging, in Ayyapuram

c) Rajapalayam Municipality

There are seven existing service reservoirs available in Rajapalayam Municipality. 11.40 LL capacity service reservoir (2 Nos) and 6.81 LL capacity service reservoir (1 No) are not considered for this project since the staging height is only 7m, 5.00 LL capacity service reservoir (1 No), 2.00 LL capacity service reservoir (2 Nos) and 1.00 LL capacity service reservoirs (1 No) are proposed to be utilized in this project. It is proposed to construct 7 more service reservoirs of various capacities in various locations of Rajapalayam Municipality are detailed below.

- 4.00 LL service reservoir, 16m staging - 1 No (Zone 9).
- 5.00 LL service reservoir, 16 staging - 2 (Zone 7,11)
- 6.00 LL service reservoir, 16m staging- 2 No at Kamarajar Nagar (Zone 13 & Zone 14).
- 6.80 LL service reservoir, 16m staging - 1 No (Zone 6).
- 7.00 LL service reservoir, 16m staging - 1 No (Zone 12).
- 8.40 LL service reservoir, 16m staging - 1 No (Zone 4).
- 11.40 LL service reservoir, 16m staging - 2 Nos (Zone 1 & Zone 2).

d) Sivakasi Municipality

There are nine number of service reservoirs available in Sivakasi Municipality. They are 12.00 LL capacity service reservoir (1 No), 9.00 LL capacity service reservoir (1 No), 5.00 LL capacity service reservoir (1 No), 3.00 LL capacity service reservoir (6 Nos). The existing 9.00 LL capacity service reservoir (1 No) is not considered for this project since the staging height is only 5.85m.It is proposed to construct 2 more numbers of

Service Reservoirs of various capacities in various locations of Sivakasi Municipality as detailed below.

- 4.00 LL service reservoir, 16m staging - 1 No near RC Church (Zone 2).
- 3.80 LL service reservoir, 16 staging – 1 No near Children health centre(Zone 10)

e) Thiruthangal Municipality

There are seven number of service reservoirs available in Thiruthangal Municipality. They are 8.00 LL capacity service reservoir (1 No), 7.00 LL capacity service reservoir (1 No), 3.00 LL capacity service reservoir (3 Nos), 2.00 LL capacity service reservoir (1 No) and 0.60 LL capacity service reservoir (1 No). It is proposed to construct 2 more Service Reservoirs of capacity 4.0 LL (1No) and 1.80 LL (1No).

f) Thiruvenkadam Town Panchayat

In Thiruvenkadam Town Panchayat, five existing service reservoirs are available. They are 1 No of 1.50 LL capacity service reservoir, 1 No. of 1.00 LL capacity service reservoir, 2 Nos. of 0.60 LL capacity service reservoirs and 1 No. of 0.30 LL capacity service reservoir. It is proposed to construct one additional service reservoir of capacity 0.60 LL, 12 staging height in the elevated area of Thiruvenkadam main hamlet (South) since the area is not being fed from the 1.50 LL capacity service reservoir of Thiruvenkadam main hamlet.

2.3.7 Distribution System

The distribution network of five Municipalities and one Town Panchayat, Size and length distribution system are given in table 2.6.and 2.7.

Table 2. 6– Size and Length of Proposed Pipes

SN	Beneficiaries	DI PIPE K7				HDPE 6KSC				Proposed distribution system Total In M	Existing distribution system proposed to be utilized In M
		400	350	300	250	200	160	140	110		
1	Sankarankoil Mpty	30	240	190	2632	1735	2288	5195	52418	64728	-
2	Puliyankudi Mpty	209	698	240	4015	2512	4420	5463	56695	74252	-
3	Rajapalayam Mpty	225	336	1954	6802	8415	9833	13580	98645	139790	-
4	Sivakasi Mpty	154	104	798	2323	3923	6559	8376	95284	117521	-
5	Thiruthangal Mpty			659	3214	2349	4693	5044	56996	72955	3477
		PVC PIPE 4 KSC									
							140	110	90		
6	Thiruvenkadam TP						110	521	10248	10879	9177

Table 2. 7– Distribution System Length Details

Sl No	Name of Municipality/ Towm Panchayat	Proposed distribution system Total in Metre	Existing distribution system proposed to be utilized in m	Total distribution system in m
1	Sankarankoil Municipality	64728	-	64728
2	Puliyankudi Municipality	74252	-	74252
3	Rajapalayam Municipality	139790	-	139790
4	Sivakasi Municipality	117521	-	117521
5	Thiruthangal Municipality	72955	3477	76332
6	Thiruvenkadam Town Panchayat	10879	9177	20056

2.4 Details of Land / Sites for proposed structures

The status and details of the land requirements for WTP and booster stations are furnished in the **Table 2.8**. The ownership details are given in **Annexure III.**

Table 2. 8– Details of Ownership

S. No	Description	Extent of Land	Survey Number	Ownership	Land Classification	Current Land Use	Required Land
1	Water Treatment Plant - Kondanagaram	15.08 Acres.	SF No. 536	Revenue Department	Meikkal Poramboke land	Dry vacant land	10.2 acres (200m x 207 m)
2	Booster station – 1 Manur	0.80 Acres	SF No. 256	Revenue Department	Mayanam	Dry vacant land	0.60 acres (60 m x 40 m)
3	Booster station – 2 Panavadalichatram	12.37 Acres. 0.56 Ares	SF No. 885/14	Local body – President of Panavadalichatram	Kulam Porambokku	Dry vacant land	0.60 acres (60 m x 45 m)
4	Booster station – 3 Sankarankovil	2 Acres	T.S. No. 4	ULB (Sankarankoil Municipality)	Municipality Land	Dry vacant land	1.50 Acres (100m x 60m)

2.5 Description of the Alignment

The alignment of raw water pumping main from the river bank from Kondanagaram is along roads owned by State High ways, National High Ways, other district highways, and Railway crossing for which permission was applied for a length of approximately 240 km. Hence no land acquisition is involved. Trees 20 Nos will be cut so far during execution. The land adjoining the alignment does not involve forests or any other sensitive areas. Even though, 200 new plantations will be proposed to be planted at the premise of intermediate booster stations in different locations of the project area.

Permission for laying conveying main in the right of way of the existing roads in national highway, state highway, railway crossing and other district roadswill be obtained from the concern authorities as given in **Table 2.9 & 2.10.** The pipe carrying bridge will be constructed during non monsoon period. The pipe carrying bridge will be supported on piers without affecting water flow. The proposed pipe carrying bridge will be constructed on of length 112.90m is proposed at Intake point in Tamirabarani River at Kondanagaram Village.

Table 2. 9-Details of Distribution Main, Raw/Clear Water Main, Gravity Mains Right of Way (ROW) etc.

Sl. No	Description	Starting Location	Ending Location	Distance (in KMs)	size of main in mm	Right of Way in metres & no of lanes available	Whether passing through private lands, road, river banks etc.	Any structures are affected enroute.	Status of permission (if required) for laying
1	Raw Water Main	Kondanagaram Village From River Bank	Kondanagaram WTP site	3.98	900	1.40/ single lane	Berm of Rural Roads, &SH Road crossing & Railway crossing	Nil	Permission will be obtained before execution
2	Clear Water Main	Kondanagaram WTP site	Sankarankoil Booster Station III	12.0 54.0	900	1.40 / single lane 1.40 / double lane	Berm of Roads, &SH Road crossing	Nil	Permission will be obtained before execution
3	Clear Water Main	Sankarankoil Booster Station III	Puiyankudi Booster Station	18.8	400	0.90 / single lane	Berm of Roads, &NH & ODR Road crossing	Nil	Permission will be obtained before execution
4	Clear Water Main	Sankarankoil Booster Station III	Sump & Service Reservoirs in Rajapalayam Municipality	33.0 9.0	600 400 to 100	1.10 / double lane 0.90/ double lane	Berm of Roads, &SH Road crossing & Railway crossing	Nil	Permission will be obtained before execution
5	Clear Water Main	Sankarankoil Booster Station III	Thiruthangal Booster Station	48.57	600	1.10 / double lane	Berm of Roads, &ODR Road crossing & Railway crossing	Nil	Permission will be obtained before execution

6	Clear Water Main	Sankarankoil Booster Station III	Service Reservoirs in Sankarankoil Municipality	3.5 KM 2.36 KM	150 to 350	0.80/ double lane 0.80/ single lane	Berm of Roads, &SH, ODR Road crossing	Nil	Permission will be obtained before execution
7	Clear Water Main	Sankarankoil Booster Station III	Sump & Service Reservoirs in Puliyankudi Municipality	5.20 KM 4.00 KM	100 to 250	0.80/ double lane 0.80/ single lane	Berm of Roads, &SH, ODR Road crossing & Railway crossing	Nil	Permission will be obtained before execution
8	Clear Water Main	Sivakasi Booster Station	Service Reservoirs in Sivakasi Municipality	3 KM 3.57KM	150 to 300	0.80/ double lane 0.80/ single lane	Berm of Roads, & SH, ODR Road crossing	Nil	Permission will be obtained before execution
9	Clear Water Main	Thiruthangal Booster Station	Service Reservoirs in Thiruthangal Municipality	3 KM 3.97 KM	100 to 250	0.80/ double lane 0.80/ single lane	Berm of Roads, & SH,ODR Road crossing & Railway crossing	Nil	Permission will be obtained before execution
10	Clear Water Main	Thiruvenkadam Booster Station	Service Reservoirs in Thiruvenkadam TP	1 KM 6.20 KM	100 to 200	0.75/ double lane 0.75/ single lane	Berm of Roads, & SH, ODR Road crossing	Nil	Permission will be obtained before execution

Table 2. 10-Distribution System (Connecting all the OHTs)

Sl. No	Description	From	To	Length in KM	Available Row (in metres) and lane details	RoW Ownership(SH, NH, Corporation, ODR, River/canal crossing etc.,)	Status of permission (if required) for laying
1	At Sankarankoil Municipality	Service Reservoirs	Inside Town limit	5.00	0.80/ single lane	SH & ODR Railways	Permission will be obtained before execution
2	At Puliyankudi Municipality	Service Reservoirs	Inside Town limit	4.98	0.90/ double lane	ODR & NH	Permission will be obtained before execution
3	At Rajapalayam Municipality	Service Reservoirs	Inside Town limit	5.12	0.90/ double lane	SH&ODR	Permission will be obtained before execution
4	At Sivakasi Municipality	Service Reservoirs	Inside Town limit	4.60	0.75/ double lane	SH &ODR	Permission will be obtained before execution
5	At Thiruthangal Municipality	Service Reservoirs	Inside Town limit	3.50	0.75/ double lane	SH & ODR Railways	Permission will be obtained before execution
6	At Thiruvenkadam TP	Service Reservoirs	Inside Town limit	1.20	0.75/ double lane	SH	Permission will be obtained before execution

2.6 Man Power Requirement

The project will provide up to more than 100 Employment opportunities in Construction Phase and 20-30 Employment opportunities in operation phase.

Sl.No	Description (Operation Phase)
1	Electrical Superintendent
2	Electrician Grade II
3	Maintenance Assistant
4	Pipeline Fitter II
5	Turn Cock
6	Watch man (Water Treatment Plant)

2.7 Power Requirement

The total power requirement for pumpsets, treatment plant and lights are estimated at **12047.244 MWh.** The pump sets details given below

Pump Set Details	No of Pump	Hp	KWA
Pumpsets for Raw water	2	220	164.12
Water Pumpset for treatment	2	240	179.04
Pumpsets for booster station I	2	270	201.42
Pumpsets for booster station II	2	200	149.2
Pumpsets for booster station III			
Sankarankoil Municipality	1	25	18.65
Puliyankudi Municipality	2	70	52.22
Rajapalayam Municipality	2	75	55.95
Sivakasi and Thiruthangal Municipalities and Thiruvengadam TP	2	35	26.11
Sump @ Puliyankudi Municipality			
Pumpsets	1	12.5	9.325
	1	10	7.46
	1	25	18.65
Sump @ Rajapalayam Municipality			
Pumpsets	1	30	22.38

	1	40	29.84
	1	40	29.84
Sump @ Sivakasi Municipality			
Pumpsets	1	25	18.65
	1	30	22.38
	1	22.5	16.785
Sump @ Thiruthangal Municipality			
Pumpsets	1	22.5	16.785
	1	20	14.92
	1	1	0.746
Sump @ Thiruvenkadam Towm Panchayat			
Pumpsets	1	4	2.984
	1	3	2.238

Other Facilities

- Electrician and Watchman Quarters will be providing for inside the water treatment plant.
- Gardening will be provided inside the water treatment plant.
- The 252 Nos of trees will be planted in water treatment plant. In addition, plantation will be provided in all booster station sites in the available space.
- The operation phase toilets, will be provided in each booster stations 1 No and 2 Nos in water treatment plant. Toilet waste will be treated by septic tank with soak pit.

2.8 Construction Schedule

It is programmed to implement the project in 30 months. The works for all the project components would be commenced simultaneously and completed in the specified period. The construction schedule is given in **Table 2.11**.

Table 2. 11- The construction schedule of combined water supply scheme

No	Description of works	Year - 2017-2020														
		Aug 17–Jan 18			Feb 18–July18			Aug 18 – Jan 19			Feb 19–July19			Aug 19 – Jan 20		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Construction of Intake cum suction well including Coffer dam around the Intake and connecting bridge -Civil Works															
2	Electrical Raw water Pump set for 46.08 MLD Scheme at Kondanagaram															
3	Raw water Piping system and accessories															
4	Raw water pumping main															
5	Water Treatment plant -46.08 MLD at Kondanagaram															
6	Clear water storage tank at Kondanagaram															
7	Clear water pump house civil works and Piping @ Kondanagaram															

8	Clear water Pumpset, Sub station @ Kondanagaram															
9	Electrical Clear water Pumpset, Sub station @ Kondanagaram															
10	Construction of Booster station I,II & III.															
11	Electrical work of Booster station I,II & III.															
12	Construction of proposed service reservoirs at Sankarankoil (3 nos) & Puliankudi Municipality (4 nos)															
13	Construction of proposed service reservoirs at Rajapalayam (10 nos) & Sivakasi (2 nos) Municipality															
14	Construction of proposed service reservoirs at Thiruthangal (2 nos) & Thiruvenkadam (1 nos) Municipality															
15	Distribution system with DI Pipe K7, HDPE pipes (110mm to 400 mm)															
16	House Service connections (1,14,045Nos)															

3. ENVIRONMENTAL REGULATORY FRAMEWORK

3.1 INTRODUCTION

This section reviews the policies, regulations and administrative framework within which the project works are to be implemented. The review includes the Environmental and Social Management Framework (ESMF) developed by TNUIFSL, Operational policies / directives of Funding Agencies through TNUIFSL, sector-specific Environmental Policies &Regulations of the Government of India and the institutional profile of various agencies such as Tamil Nadu Pollution Control Board (TNPCB) and other stakeholders associated with the project.

3.2 ENVIRONMENTAL POLICIES AND REGULATIONS

The environmental policies and regulations reviewed are broadly divided into the following four categories:

- Environmental and Social Management framework (ESMF)
- Operational policies of external Funding Agencies
- Environmental Policy and Regulatory Frameworks in India
- Regulatory Framework in the State of Tamil Nadu

3.2.1 Environmental and Social Management Framework

From Various Funding Agencies through TNUIFSL, under which the proposed water supply project is to be funded, has formulated an exclusive Environmental and Social Framework to address Environmental and Social Impacts associated with infrastructure projects. Environmental and Social Management framework (ESMF) is in line with the Environmental and Social safeguard Policies and directives of the Various Funding Agencies through TNUIFSL.

The proposed activity has no social impact and hence the project falls under **S3**as per **Social Categorization of ESMF** and is classified as **E1**as per **Environmental Categorization of ESMF.** Hence this project requires detailed environmental impact assessment and preparation of management measures.

3.2.2 Operational Policies and Directives of World Bank

- OP 4.01 for safeguard policies of World Bank which provides for the environmental assessment guidance for the lending operations is applicable. This OP 4.01 requires the borrower to screen projects for potential impacts and through appropriate EA assess, minimize and mitigate potentially adverse impacts from the project.
- The Environmental Assessment (EA) leads to be integrated in the project development process such that timely measures can be applied to address the identified impacts.
- Environmental Health and Safety guidelines of the World Bank are applicable for the project which will be ensured during project implementation.

3.2.3 Source Clearance

Approval for the proposal to tap 61.98 MLD of water from River Tamirabarani near Kondanagaram village from Water Utilization Committee of PWD is under process.

S.NO	Activity	Clearance / NOC Required	Statutory Authority	Status
1	Withdrawal of raw water (61.98 MLD) from Tamira barani River	Clearance to be obtained from Water Utilization Committee of PWD for 61.98 MLD for the Ultimate stage Demand.	PWD – Water Utilisation Committee	Proposal Under Scrutiny at CE'S Office/PWD/WRO/ Madurai

In Regional Scientific Source Finding Committee and State Level Technical Committee, TWAD have cleared the proposal to tap water from Tamirabarani River considering that the source is perennial and sustainable.

3.2.4 Environmental Policy and Regulatory Frameworks in India

The following are the key regulations in India applicable for various development projects.

- Constitutional Provisions
- The Environment (Protection) Act, 1986

- The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013
- Forest (Conservation) Act, 1980 - as amended in 1988.Water (Prevention and Control of Pollution) Act, 1974 – and Tamil Nadu Water (Prevention and Control of Pollution) Rules, 1974
- Air (Prevention and Control of Pollution) Act, 1981 and Tamil Nadu Air (Prevention and Control of Pollution) Rules, 1983
- The Treasure Trove Act, 1878
- Hazardous Wastes (Management & Handling) Rules, 1989;
- Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989
- Noise Pollution (Regulation and Control) Rules, 2000

This section reviews the policies, regulations and administrative framework within which the project is to be implemented. The review includes the Environmental and Social framework of TNUIFSL, operational policies / directions of the World Bank and sector-specific environmental policies and regulations of the Govt. of India and Govt. of Tamilnadu.

a) Constitutional Provisions

The Constitution of India in its Article 48 provides for the protection and preservation of the environment and states that "the state will endeavour to protect and improve the environment and to safeguard forests and wild life of the country." Further Article 51-A (g) on fundamental duties emphasizes that, "It will be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for living creatures."

b) The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013

This Act ensures essential infrastructural facilities and urbanisation with least disturbance to the owners of the land and other affected families and provides just and fair compensation for land acquisitions. The proposed project does not have any private land acquisitions.

c) Forest (Conservation) Act, 1980

The Act pertains to diversion of forestland and felling of roadside plantation. Depending on the size of the tract to be cleared, clearances are to be obtained. Restrictions and clearance procedures proposed in the Forest (Conservation) Act apply to the natural forest areas, even in case the protected/designated forest area does not have any vegetation. The pumping main of the proposed project does not cross any natural forest areas.

d) The Environment Protection Act 1986, & Notifications

In order to create national environmental legislation, the EPA articulates a policy for environmental protection covering air, water and land and provide a framework for Central Government to coordinate between Central and State Authorities established under various laws, including the Water Act and Air Act. Under this umbrella Act, the Central Government must set National Ambient and Emissions Standards, establish procedures for managing hazardous substances, regulate industrial sites, investigate and research pollution issues and establish laboratories and collect and disseminate information.

Among other relevant legislation, the Public Liability Insurance Act (PLIA) of 1991 mandates that business owners operating with hazardous substances take out insurance policies covering potential liability from an accident and establish Environmental Relief Funds to deal with accidents involving hazardous substances. The National Environmental Appellate Authority Act of 1997 requires the Central Government to establish an authority to hear appeals on area restrictions where operations will not be carried out or will be carried out with certain safeguard measures.

e) The Air (Prevention and control of pollution) Act, 1981amended in 1987

This Act provides prevention, control and abatement of air pollution. With a framework similar to the Water Act, the Air Act gave the central and State Board's authority to issue consents to industries operating within the designated air pollution control areas. The State also prescribes emission standards for stationary and mobile sources. Since the proposed project involves operation of DG sets, the above said Act and emission standards will be complied.

f) Water (Prevention & Control) Act 1974

Water Act is the first environmental regulation that brought at the state and center levels, pollution control boards to control / regulate environmental pollution in India. The Act was amended in 1978 and 1988. Salient features of the Act are the following:

- **Section 25** of the Act requires an application to be made to the state board to establish any treatment and disposal system that is likely to discharge sewage or trade effluent in to a stream or well or sewer on land

These laws seek to control pollution of water and enhance the quality of water. Under this law, it is mandatory to obtain consent to establishment for in case of any outlet for disposing waste/ effluent.

g) The Treasure Trove Act, 1878

The Indian Treasure Trove Act, 1878 (Act No. VI of 1878) was promulgated to protect and preserve treasure found accidentally but having the archaeological and historical value. This Act was enacted to protect and preserve such treasures and their lawful disposal. In a landmark development in 1886, James Burgess, the then Director General succeeded in prevailing upon the Government for issuing directions forbidding any person or agency to undertake excavation without prior consent of the Archaeological Survey and debarring officers from disposing of antiquities found or acquired without the permission of the Government.

h) The Noise Pollution (Regulation and Control) Rules, 2000

In order to curb the growing problems of noise pollution, the government of India has enacted the noise pollution rules 2000 that includes the following main provisions:

- The state government may categorize the areas as industrial or commercial or residential.
- The Ambient air quality Standards in respect of Noise for different areas has been specified.

- The State government will take measures for abatement of noise including noise emanating from vehicular movement and ensure that the existing noise levels do not exceed the ambient air quality standards specified under these rules.
- Areas not less than 100 m around Hospitals, Educational institutions and Court is declared as silence area under these rules.
- A person found violating the provisions as to the maximum noise permissible in any particular area will be liable to be punished for it, under the provision of these rules and any other law in force.

i) Manufacture, Storage and Import of Hazardous Chemical Rules, 1989

These rules aim at controlling the generation, storage and import of hazardous chemicals. These Rules are applicable to an industrial activity or isolated storage in which there is involved a quantity of hazardous chemical listed in the Schedule of the Rules which is equal to or more than the quantity specified in the entry for that chemical in the Schedule. According to these rules, the user of hazardous chemicals has to perform the following and dispose hazardous waste as mentioned in the rules.

- Identify the potential hazards of the chemicals and take adequate steps to prevent and control such hazards
- Develop or provide information about the chemical in the form of safety data sheets
- Label the specified information on the container of the hazardous chemical

Chlorine used as a disinfectant in ULBs sumps is categorized as hazardous chemical as per MHSIC rules 1989. Maximum 3 Tonnes of Chlorine is stored at the ULBs sumps and does not attract the provisions of these rules.

(Note: On exceeding 5 nos of chlorine cylinders licence from PESO under Gas Cylinders Rules to be obtained.). Hence obtaining licence from PESO does not arise.

3.2.5 Regulatory Framework in the State of Tamil Nadu

Railway Crossings:

Permission from Southern Railways has to be obtained in order to lay pipelines crossing the railway lines. The detail of Railway crossings are given in **Table 3.1**.

Table 3. 1– Details of Railway Crossings

S. NO	LOCATION	CO ORDINATES
1	Pipeline from intake well crossing Railway line at Kondanagaram on the way to Water Treatment Plant	08° 43' 08.40" N 77° 37' 21.54" E
2	Pipeline from Sankarankoil Booster station crossing Railway line at Sankarankoil on the way to Puliyankudi	09° 10' 27.99" N 77° 31' 18.96"E
3	Pipeline crossing Railway line at Thiruthangal on the way to sump at Thiruthangal	09° 27' 52.41"N 77° 47' 28.77" E
4	Pipeline crossing Railway line at Thiruthangal on its way from the sump to the service reservoir at Pappankulam	09° 28' 47.22" N 77° 48' 52.78" E
5	Pipeline crossing Railway line at Sankarankoil on the way to Rajapalayam	09° 11' 08.40" N 77° 32' 05.72"E
6	Pipeline crossing Railway line at Rajapalayam	09° 26' 28.40" N 77° 33' 41.29"E

Highway Crossings

The pumping main crosses the following state highways:

- SH 41A (Tirunelveli to Ambasamudram)
- SH 39 (Tirunelveli to Tenkasi)
- SH 41 (Rajapalayam to Sankarankoil)
- SH 187 (Sivakasi to Sattur)

The distribution network crosses the National and State highways, the detail is given in **Table 3.2**.

Table 3. 2– Details of National and State Highways Crossings

S.No	Location	Highway	No. of Crossings
1	Sankarankoil	SH 41	1
2	Puliyankudi	NH 208	5
3	Rajapalayam	SH 41	8
4	Sivakasi	SH 187, SH 185, SH 42	12
5	Thiruvenkadam	SH 44	3
6	Thiruthangal	SH 42	10

3.2.6 Clearances/ NOC Required from Competent Authority

The summary of applicable **Clearance / NOC** required for the proposed project is given in **Table 3.3.**

Table 3. 3 Clearances/ NOC Required from Competent Authority

S.NO	Activity	Clearance / NOC Required	Statutory Authority	Status
1	Withdrawal of 46.08 MLD from Tamirabarani River	No objection certificate	WUC/PWD	Proposal Under Scrutiny at CE'S Office/PWD/WRO/ Madurai
2	Construction of intake well and FOB in river.	No objection certificate	WUC/PWD	Proposal Under Scrutiny at CE'S Office/PWD/WRO/ Madurai
3	Conveyance line crossing and laying near local roads and Highways	No objection certificate	Highways Authority	Permission will be obtained prior to execution
4	Conveyance line crossing Railway line	No objection certificate	Railway Department	Permission will be obtained prior to execution
5	Cutting of trees in the area	No objection Certificate	Revenue Department	Permission will be obtained prior to execution

4. BASELINE ENVIRONMENTAL PROFILE

4.1 Introduction

Baseline Environmental Studies have been conducted to determine the existing status of various Environmental attributes viz., Climatic and Atmospheric conditions, Air, Water, Noise, Soil, Hydro geological, Land use pattern, Ecological and Socio-Economical environment, prior to setting up of the proposed project. This study would help to undertake corrective mitigation measures for protection of the environment on account of any change deviation of attributes due to activities of the proposed project.

4.2 Scope of Baseline Study

All the proposed project sites for Water Treatment Plant, Booster stations and overhead tanks are considered as the study area for the baseline studies. As part of Environmental and Social Impact Assessment, this study was undertaken for a period from Nov 2015- Feb 2016. Primary data on Water, Air, Land, Flora, Fauna & Socio-Economic data were collected by a team of Engineers and Scientists. Secondary data was collected from various Departments of State/Central Government Organizations, Semi-Government and Public Sector Organizations. **Table 4.1** gives various environmental attributes considered for formulating environmental baseline study.

1	Primary data- Collected from field	Water, Noise, Air, Soil, Flora, Fauna, and Social economic
2	Secondary data-refers to data was collected from various Departments	Wind Rose data, Ecology and Aquatic Data

Table 4.1- Baseline Environmental Components, Frequency & Monitoring Methodology

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
1. Air Environment				
Meteorological Data				
• Wind speed • Wind direction • Dry bulb temperature • Wet bulb temperature • Relative humidity • Rainfall	Requisite locations in the project influence area.		Weather Monitoring Station	IS 5182 Part 1-20 Sit-specific Primary data is essential Secondary data from IMD-Regional Meteorological Centre, Chennai.
Ambient Air Quality				
• Suspended Particulate Matter (SPM) • Particulate Matter (PM_{10}) • Particulate Matter ($PM_{2.5}$) • Sulphur Di-oxide (SO_2) • Oxides of Nitrogen (NO_X) • Ammonia	Requisite locations in the project influence area.	24 hourly (Twice a week) 8 Hourly (Twice a week)	• Gravimetric (High–Volume) • Gravimetric (High– Volume with Cyclone) • EPA Modified West & Geake method • Arsenite Modified Jacob & Hochheiser • Nessler's method.	As per CPCB Standards under November 18th 2009 Notification for NAAQS
2. Noise Environment				
Hourly equivalent noise levels	Requisite locations in the project influence area	One day Continuous on a working and non-working day.	Sound level meter.	IS: 4954-1968

3. Water environment				
Parameters for water quality: pH, temp, turbidity, Total hardness, total alkalinity, chloride, sulphate, nitrate, fluoride, sodium, potassium, Electrical Conductivity, Ammonical nitrogen, Nitrate-Nitrogen total phosphorus, , BOD, COD, Calcium, Magnesium, Total Dissolved Solids, Total Suspended Solids	Set of grab samples At requisite locations for ground and surface water	Once	Samples for water quality collected and analyzed as per Standard methods for examination of water and wastewater analysis published by American Public Health Association.	
4. **Land Environment**				
• Soil quality • Particle size distribution • Texture • pH • Electrical conductivity • Caution exchange capacity • Alkali metals • Sodium Absorption Ratio (SAR) • Permeability • Porosity	Requisite soil samples be collected as per BIS specification within project influence area	Once	Collected and analyzed as per soil analysis reference book, M.L. Jackson	
5. **Land Use**				
• Location code • Total project area • Topography • Drainage (natural) • Cultivated, forest plantations, water bodies, roads and settlements	-	-	• Global positioning system • Topo-sheets • Satellite Imageries	From land use maps sensitive receptors (forests, parks, mangroves etc.) can be identified.

6. Biological Environment				
Terrestrial				
Vegetation – species, list, economic importance, forest produce, medicinal value, Importance value index (IVI) of trees, Wild animals **Avifauna** Rare and endangered species Sanctuaries/National park/Biosphere reserve		One season for terrestrial biota, in addition to Vegetation studies during monsoon season	• Point quarter plot-less method (random sampling) for Terrestrial vegetation survey. • Secondary data to collect from Government offices, NGOs, published literature	
Socio-Economic				
• Demographic structure • Infrastructure resource base • Economic resource base • Health status: Morbidity pattern • Cultural and aesthetic attributes	Socio-economic survey is based on proportionate, stratified and random sampling method		• Survey is based on personal interviews and questionnaire. • Secondary data from census records, statistical hard books, health records and relevant official records available with Govt. agencies	

4.3 Sampling Locations

Sampling locations are selected for Air, Water, Noise and Soil. All the samples are analyzed and results are shown below:

The Air, Noise, Water and Soil Sampling locations were selected based on the following criteria. The Ambient air quality monitoring locations have been designed keeping in view the available climatologically norms of predominant wind direction and wind speed of the area.

The following points were also taken into consideration in designing the sampling locations

- Topography and terrain of the study area.
- Populated areas within the study area.
- Residential and sensitive area within the study area.

For the noise monitoring locations the above factors has been considered. Water sampling locations were collected based on the availability of the bore wells / open wells in the area. Geological environment has been considered for the collection of Soil sample collection.

4.4 Micro Meteorology

4.4.1 Temperature

The mean minimum and maximum daily temperature for Tirunelveli District are 22.9°C and 33.5°C respectively. The mean minimum and maximum daily temperature for Virudhunagar District are 23.78°C and 33.95°C respectively.

4.4.2 Rainfall

Tirunelveli District

The district receives the rain under the influence of both southwest and northeast monsoons. The northeast monsoon chiefly contributes to the rainfall in the district. Rainfall data from IMD stations over the period 1901-2000 were utilized and a perusal of the data shows that the normal annual rainfall over the district is 879 mm. It is the maximum around Senkottai, Ambasamudram andall along the coast and it decreases towards inland. The areas around Sankarankoil, Tirunelveli and Kadayanallur receive minimum rainfall.

Virudhunagar District

The district receives the rain under the influence of both southwest and northeast monsoons. The northeast monsoon chiefly contributes to the rainfall in the district. Rainfall data from seven stations over the period 1901- 2000 were utilized for analysis and a perusal of the data shows that the normal annual rainfall over the district varies from about 724 to 913 mm. It is minimum around Sattur in the south eastern part of the district.

4.4.3 Relative Humidity

The relative humidity for Tirunelveli District is on an average between 79 and 84%.The relative humidity for Virudhunagar District is on an average between 65 and 85% in the mornings. Humidity in the afternoon is generally between 40 and 70%.

4.4.4 Wind Speed Direction in Project Site (WTP)

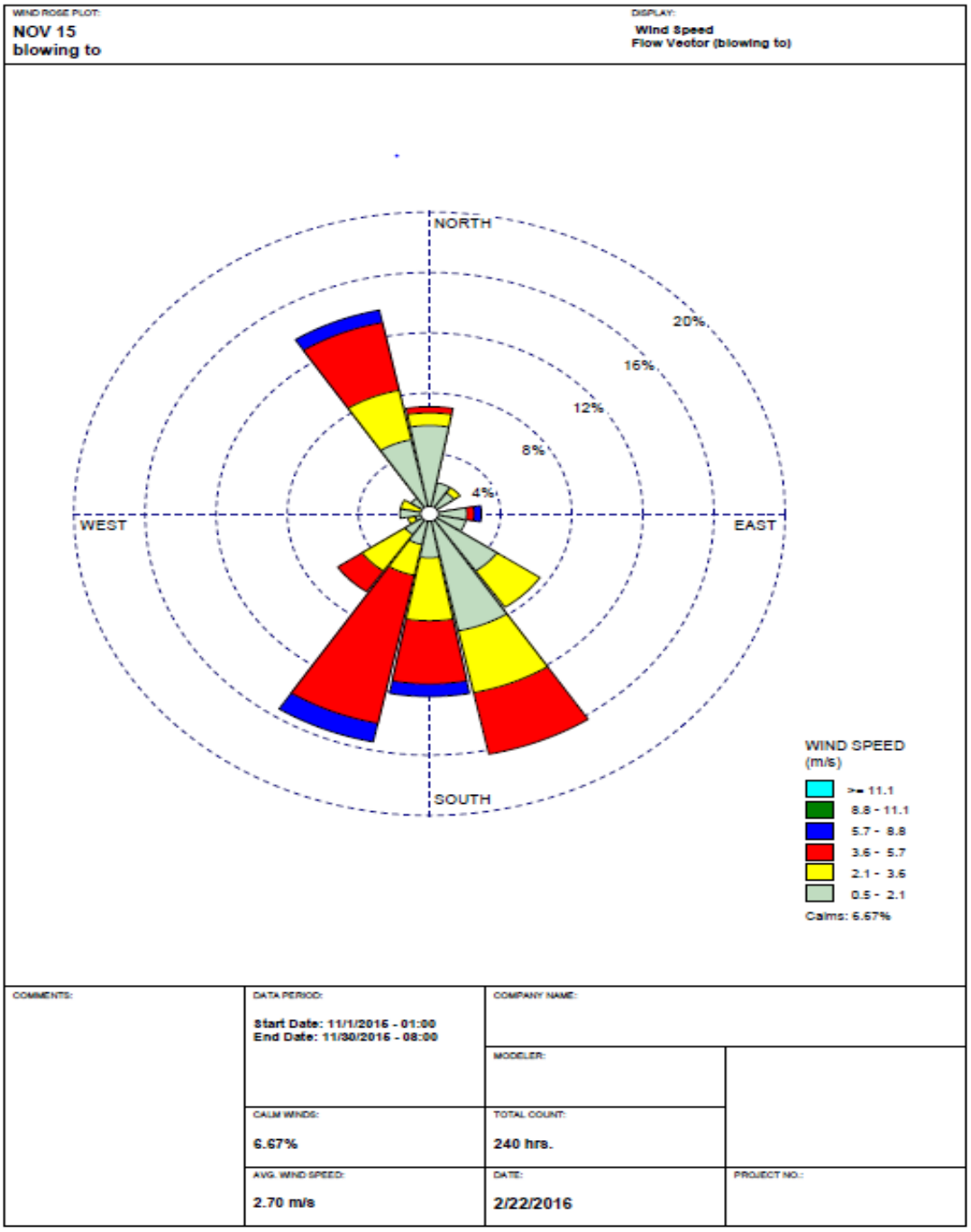


Figure 4. 1- Wind rose for December 2016

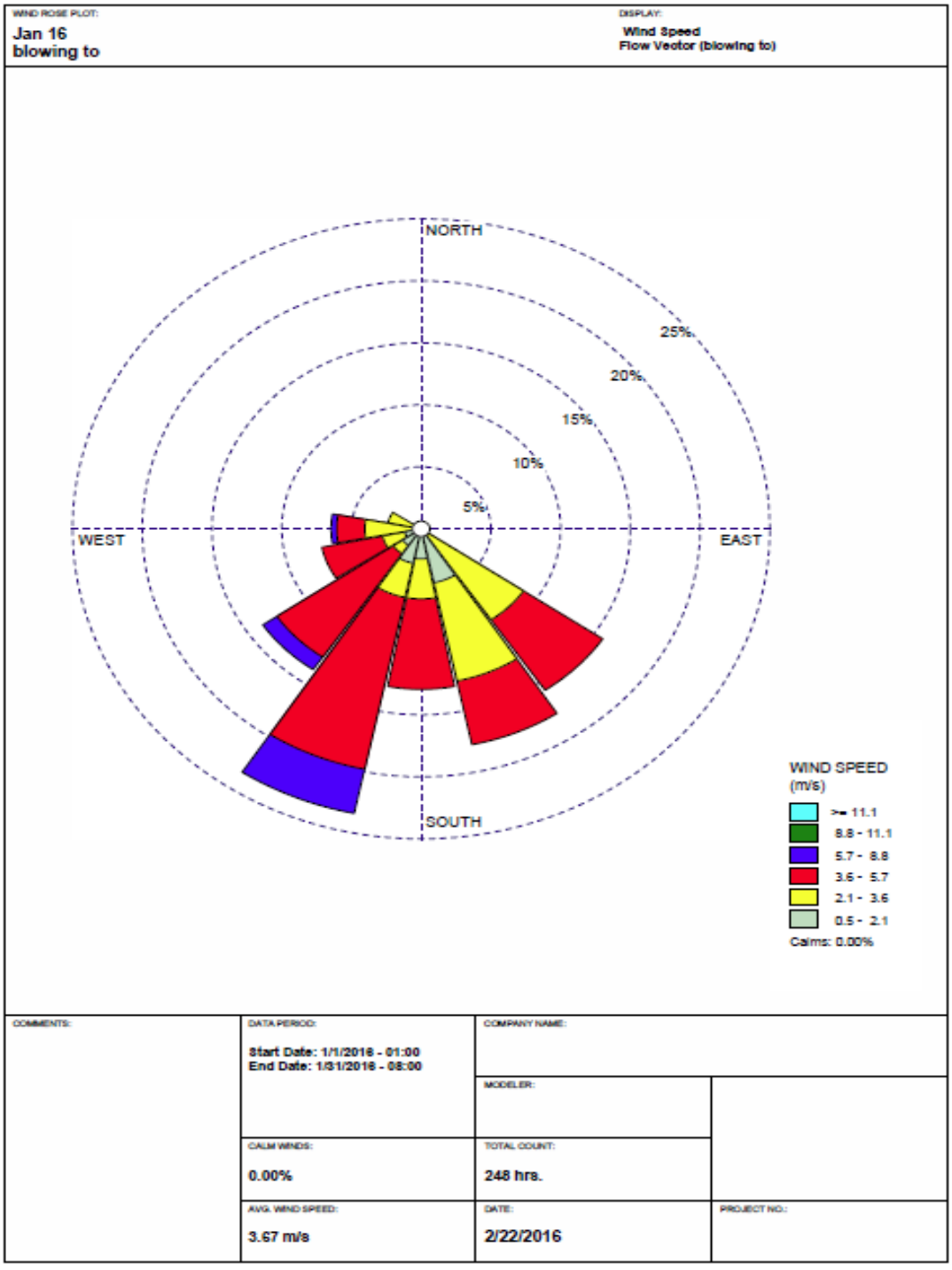


Figure 4. 2- Wind rose for January 2016

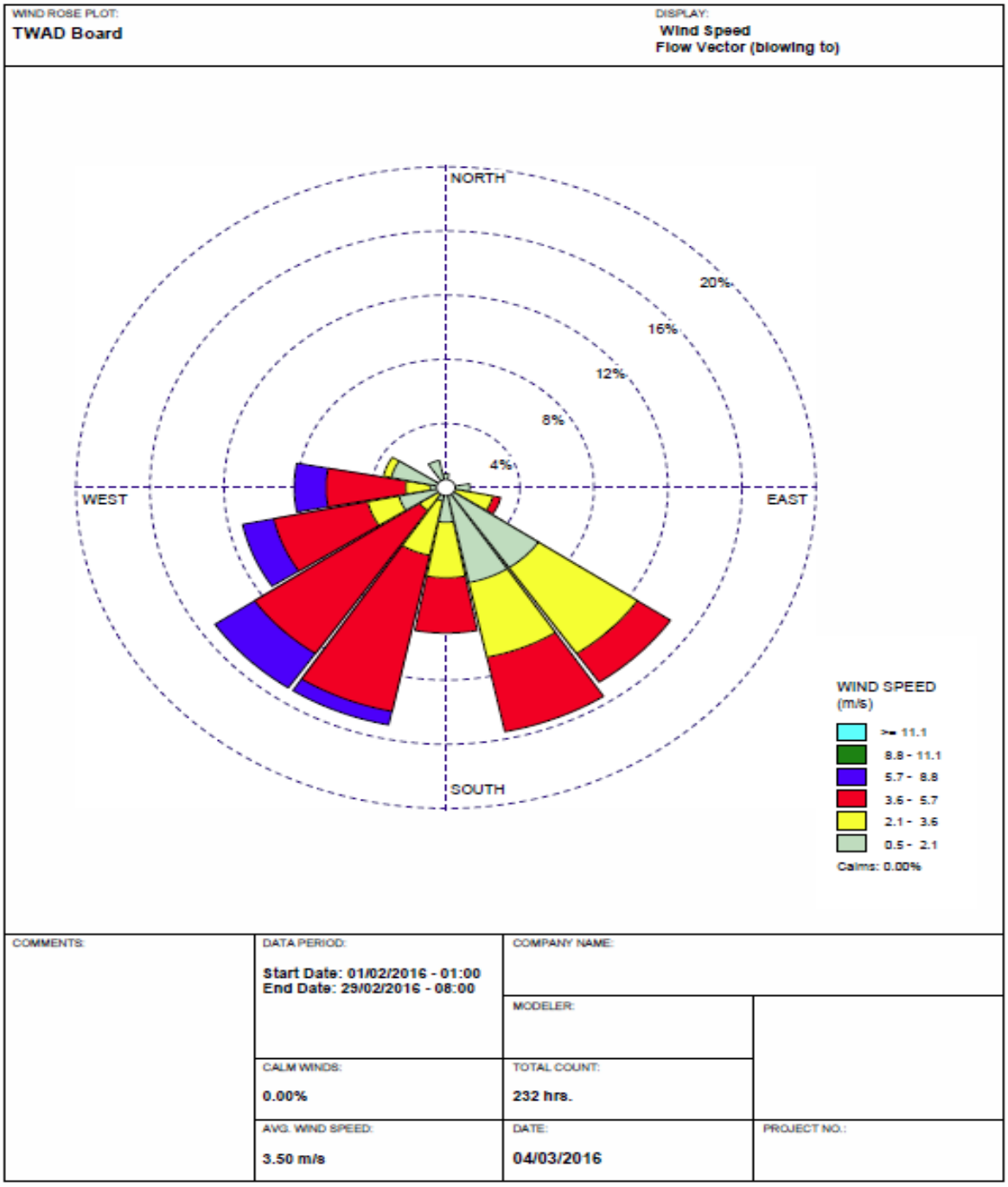


Figure 4. 3- Wind rose for February 2016

4.5 Air Environment

4.5.1 Ambient Air Quality (AAQ)

The Ambient Air Quality (AAQ) status with respect to the study zone of 10 km radial distance from the plant site formed the baseline information over which the predicted impacts due to the proposed project were determined based on which the Environmental Management Plan (EMP) was prepared. The baseline status of the ambient air quality can be accessed through a scientifically designed ambient air quality-monitoring network based on the following considerations:

a) Meteorological conditions on synoptic scale

b) Topography of the study area

c) Representations of regional background levels

d) Representation of plant site

e) Representation of cross sectional distribution in the downward direction

f) Influences of the existing sources if any are to be kept at minimum

g) Inclusion of major distinct villages to collect the baseline status

h) The assessment of the impacts on air environment from the proposed activity was carried out using ambient air quality data monitored during the study period.

4.5.2 Monitoring Location and Methodology

To establish the existing baseline status of air quality a network of 10 AAQ sampling locations were selected. The locations were decided on the basis of meteorological data and the topography of the area. The parameters and analytical technique is given in **Table 4.2.**

Table 4.2- Techniques used for Baseline analysis

S.No	Parameter	Technique
1	Particulate Matter (PM10 & PM2.5)	PM10 Particulate Sampler & Fine Particulate Sampler (Gravimetric method)
2	Respirable Particulate Matter	Respirable Dust Sampler (Gravimetric method)
3	Sulphur Dioxide	Modified West and Gaeke
4	Nitrogen Oxide	Jacob & Hochheiser

4.5.3 Results and Discussions

The existing ambient air qualities at the identified locations are given in **Figure 4.4** and the corresponding standards are presented in **Table 4.3**. The table below lists minimum, maximum, 98th percentile and mean values of concentrations of PM10, PM2.5, SO_2, and NO_x are monitored.

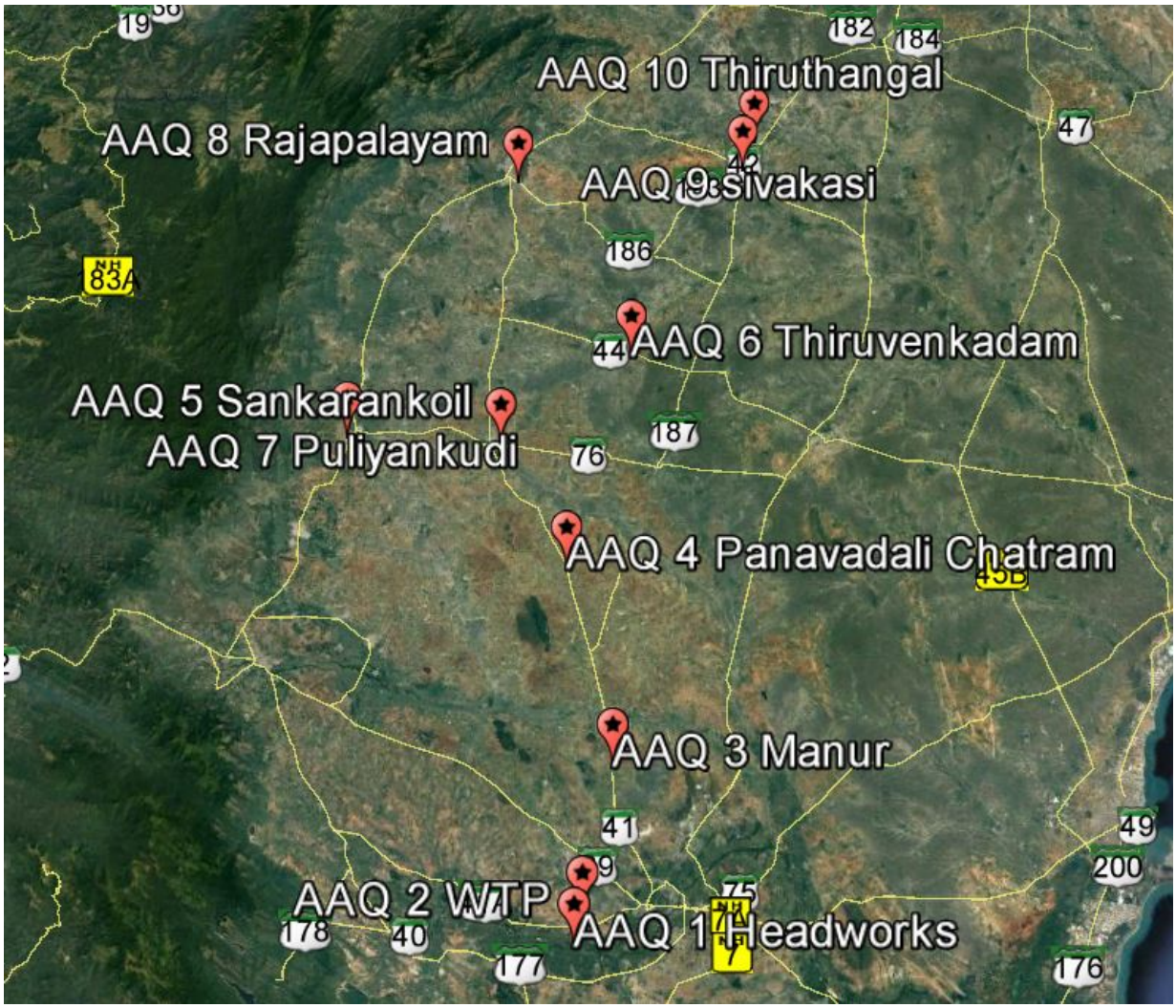


Figure 4. 4- Air Sampling Locations

Table 4.3-Ambient Air Quality Results

Code	Location	PM_{10} µg/m³				$PM_{2.5}$ µg/m³				SO_2 , µg/m³				NO_X, µg/m³			
		Min	Max	Avg	98 %	Min	Max	Avg	98 %	Min	Max	Avg	98%	Min	Max	Avg	98 %
AAQ1	Headwork-Kondanagaram	37.4	50.2	43.4	50.0	18.7	26.1	21.9	26.0	5.2	7.3	5.9	7.1	10.6	14.8	13.0	14.7
AAQ2	Treatment Plant-Kondanagaram	34.9	44.2	40.1	44	15.9	20.4	17.3	19.9	5.1	6.3	5.6	6.25	9.1	13.4	11.2	13.2
AAQ3	Booster Station-Manur	45.9	62	53.9	62.0	21.9	28.1	24.7	27.8	6.1	8.3	7.0	8.2	14.9	19.6	16.9	19.5
AAQ4	Booster Station-Panavadali Chatram	46.7	58.2	49.5	56.2	20.3	27.6	23.8	27.5	5.7	7.9	6.6	7.9	12.1	17.2	14.0	17.0
AAQ5	Booster Station-Sankarankoil	52.1	66.3	58.2	66.1	24.1	32.7	27.4	32.7	7.1	9.4	8.4	9.4	15.9	20.3	17.5	20.1
AAQ6	Sump - Thiruvenkadam	40.9	53.4	46.6	53.2	17.6	23.6	20.1	23.5	5.3	7	6.0	7.0	11.4	17.1	14.9	17.0
AAQ7	Sump - Puliyankudi	51.7	69.1	58.9	67.9	22.9	34.1	28.8	34.1	6.1	8.6	7.4	8.6	13.1	18.7	15.8	18.5
AAQ8	Sump-Rajapalayam	64	79.1	71.5	78.8	29.6	38.6	34.8	38.4	8.8	11.6	10.2	11.5	17.3	26.9	22.4	26.4
AAQ9	Sump-sivakasi	60.9	77.9	69.9	75.9	32.6	38.4	35.2	38.3	9.1	11.9	9.9	11.3	19	26.8	20.9	26.1
AAQ10	Sump-Thiruthangal	55.8	67.1	59.3	65.6	25.3	33.1	28.0	32.0	6.9	10.7	8.7	10.7	15.1	20.4	17.6	20.1
CPCB / MoEF Standards																	
Industrial /Residential / Rural and Other Area		100				60				80				80			

4.5.4 Observation for AAQ Results

The maximum value (PM_{10}) of 79.1µg/m^3 was observed at Rajapalayam (AAQ 8). The lower value of 34.9µg/m^3 was observed at Kondanagaram (AAQ2). The maximum value ($PM_{2.5}$) of 38.6 µg / m^3 was observed at Rajapalayam (AAQ8) and minimum value of 15.9 was observed at Kondanagaram (AAQ2). The maximum value of **SO_2** 11.9 µg / m^3 was observed at Sivakasi (AAQ9) and minimum value of 5.1 µg / m^3 was observed at Kondanagaram (AAQ2). The maximum value for NO_x is 26.9 µg / m^3 and was observed at Rajapalayam (AAQ8) and minimum value of 9.1 µg / m^3 was observed at Kondanagaram (AAQ2). However, all the ambient air quality levels are found to be within the CPCB Standards.

4.6 Noise Environment

The baseline noise levels in and around the project site were established in-line with the Noise Standards. Noise monitoring stations are selected by considering sensitive receptors. Noise monitoring was carried out at following 10 locations given in **Figure 4.5.**

Noise levels were monitored using a calibrated portable noise level recorder on an hourly basis for 24 hours, once at each location. Levels of noise monitored during 6.00 AM to 10.00 PM were considered for the day noise levels and those monitored during 10.00 PM to 6.00 AM were considered for night noise levels. Day and night Leq values were computed based on the monitored noise levels and are presented in **Table 4.4**.

Table 4.4-Noise Monitoring Locations & Results

S.No	Location	Lday	Lnight	Leq
N1	Headwork Kondanagaram	52.1	40.3	50.5
N2	TP- Kondanagaram	46.9	38.6	45.4
N3	Manur	53.2	42.0	51.6
N4	Panavadalichatram	50.8	39.1	49.1
N5	Sankarankoil	53.2	42.5	51.6
N6	Thiruvenkadam	51.9	39.6	50.3
N7	Puliyankudi	52.4	40.3	50.8
N8	Rajapalayam	57.6	51.3	56.3
N9	Sivakasi	56.1	49.1	54.8
N10	Thiruthangal	53.9	42.6	52.2

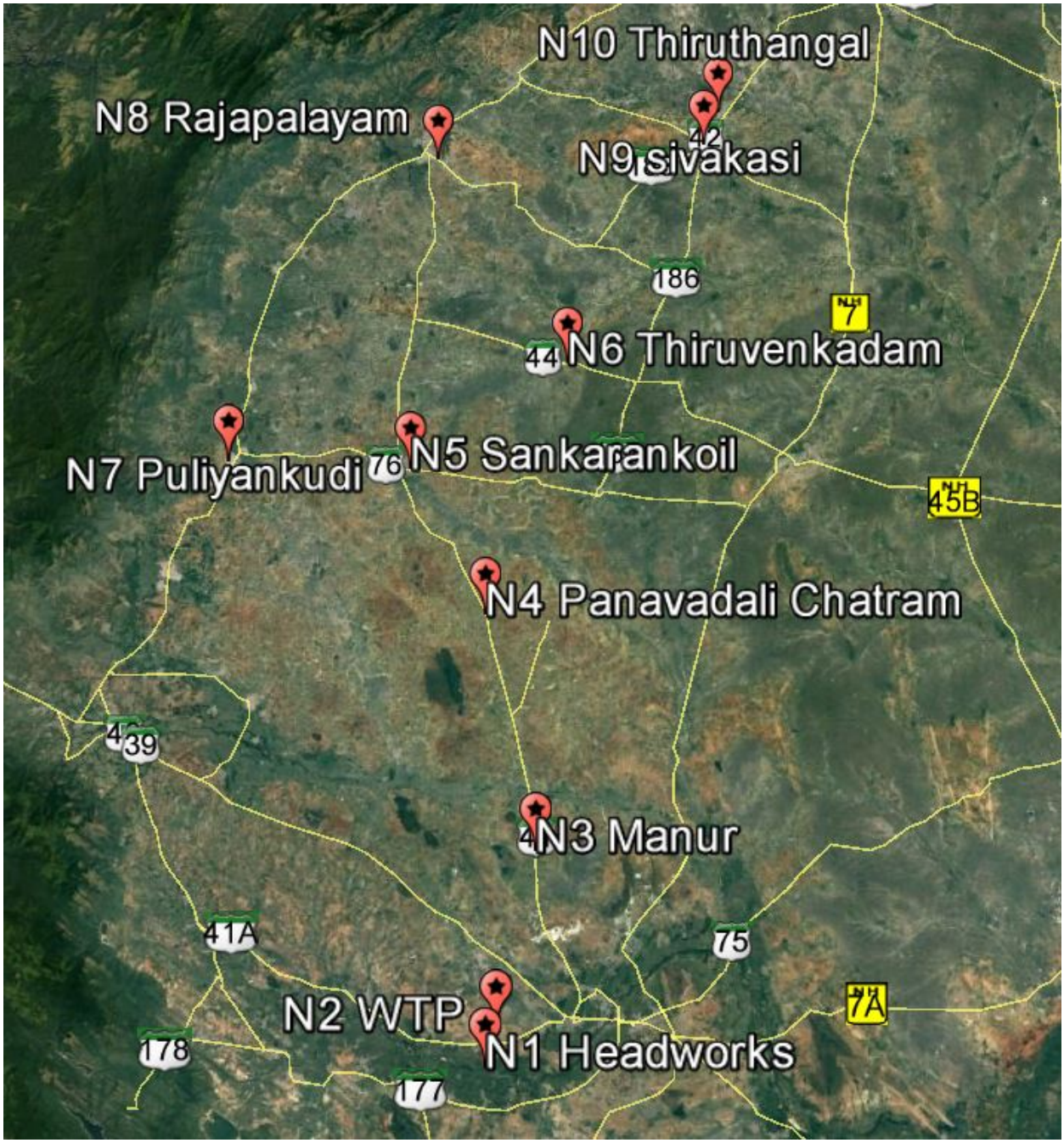


Figure 4. 5-Noise Sampling Locations

4.7 Water Environment

4.7.1 Surface Water

The Tamirabarani River originates from the peak of the Pothigai hills on the eastern slopes of the Western Ghats at an elevation of 1,725 metres (5,659 ft) above sea-level. The river is joined by its headwater tributaries Peyar, Ullar, Pambar before it flows into the Kariyar Dam reservoir, where it meets Kariyar. The river forms the Vaanatheertham waterfalls, 40 metres (130 ft) high, as it enters the Kariyar reservoir. From the source to sea, the river is about 125 kilometres (78 mi) long.

Remarks: Sampling locations was so chosen near the proposed Headwork.

4.7.2 Ground Water

The depth to water level in Tirunelveli district varied between 1.19 to 13.35 m bgl during pre monsoon and varied between 0.18 to 7.97 m bgl during post monsoon. The depth to water level in the Virudhunagar district varied between 0.67 and 12.12 m bgl during pre-monsoon and varied between 0.49 and 8.78 m bgl during post monsoon.

4.7.3 Water Quality assessment

Detailed water quality assessment is necessary in areas where there is intensive ground water development, Industrialization and urbanization as it is also subjected to qualitative changes in the environment around. Quality of water is influenced considerably by the quality of its source and occurrence. In order to describe and assess the impact on water quality by the proposed project, ground water and surface water samples at 15 locations were collected within the 10 km radius and tested for physical and chemical parameters.

4.7.4 Sampling and Analysis

Initially, reconnaissance survey was carried out to identify suitable water sample collection locations. During the reconnaissance survey on site, TDS and pH were tested and the locations were captured using GPS. While selecting the sampling locations for detailed hydro geochemical analysis the following were given much importance.

- Those water bodies on which human activities could have an impact, either by utilizing water or by discharging effluents.
- Water abstraction and utilization by domestic users.

14 water sources were selected for sampling for ground water and 1 surface water sampling point was selected and ground water collected at once and surface water collected once in a month for 4 months in Tamirabarani River. There are no major industries in the downstream and upstream of the river. Thus the water is free from Industrial effluents. The location of water sample is given in **Figure 4.6**. The ground water analysis report is given in **Table 4.5** and surface water average value was given in **Table 4.6.**

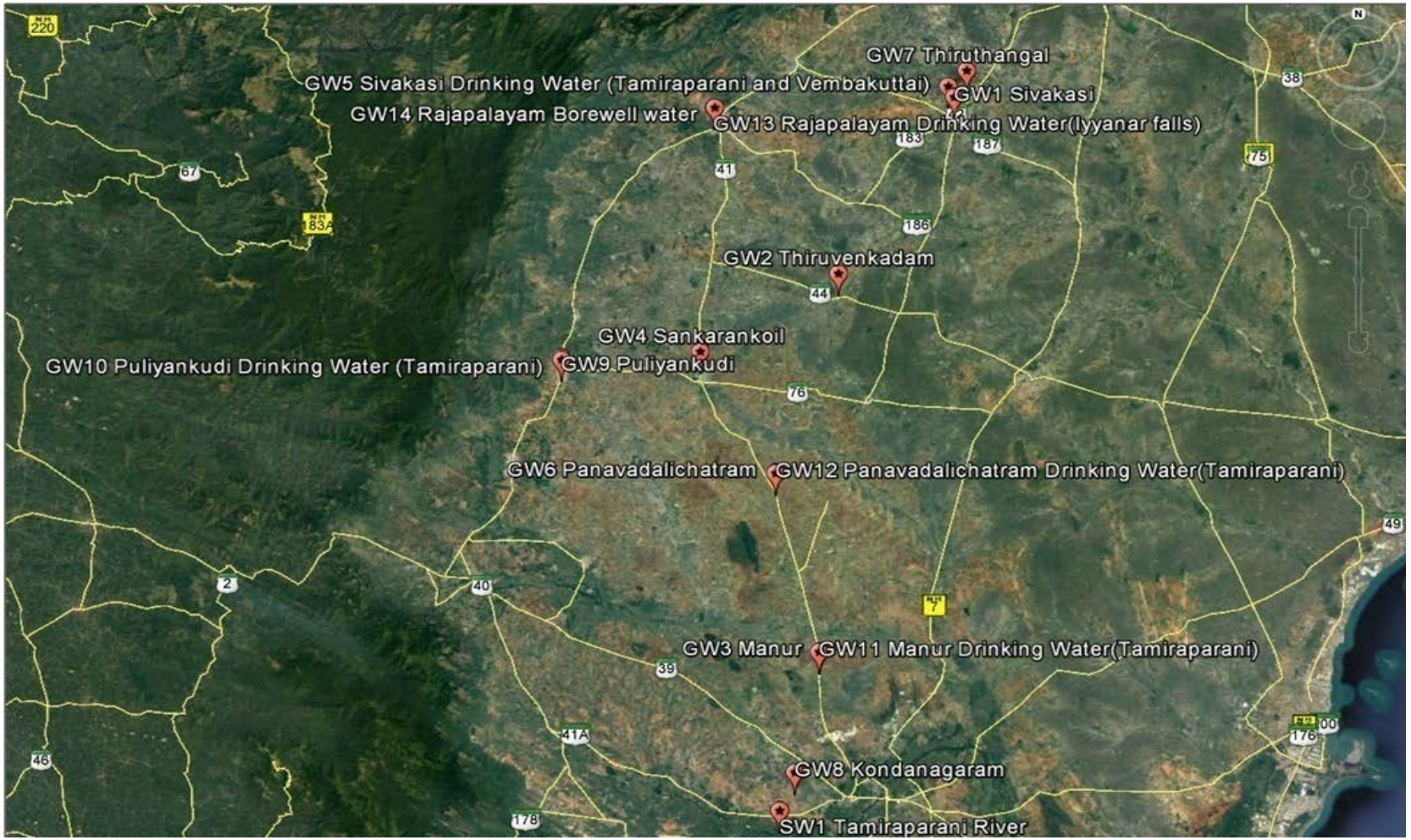


Figure 4. 6– Water Sampling Locations

Table 4.5-Ground Water quality results

S. No	Parameters	Unit	Test method	Limit as per IS 10500 : 2012	GW1	GW2	GW3	GW4
1	Colour	Hazen	APHA 22nd EDITION	5	3	1	Nil	2
2	Odour	-	APHA 22nd EDITION	Unobjectionable	No Odour Observed	No Odour Observed	No Odour Observed	No Odour Observed
3	pH at 25°C	-	IS : 3025 Part 11-1983 (Reaff: 2002)	6.5-8.5	7.20	7.50	7.08	6.81
4	Electrical Conductivity,	µS/cm	IS : 3025 Part 14-1984 (Reaff: 2002)	Not Specified	2100	9770	4250	2150
5	Turbidity	NTU	IS : 3025 Part 10-1984 (Reaff: 2002)	1	1.9	0.6	BDL(<0.5)	1.2
6	Total Dissolved Solids	mg/l	IS : 3025 Part 16-1984 (Reaff: 2003)	500	1198	5960	2510	1231
7	Total Hardness as CaCO3	mg/l	IS : 3025 Part 21-2009	200	730	2580	880	520
8	Total Alkalinity as CaCO3	mg/l	IS : 3025 Part 23-1986(Reaff:2003)	200	320	460	460	260
9	Chloride as Cl	mg/l	IS : 3025 Part 32-1988 (Reaff: 2003)	250	352	2104	723	293
10	Sulphate as SO_4	mg/l	APHA 22nd EDN-4500- SO_4^{2-} E	200	92	1177	283	88
11	Fluoride as F	mg/l	APHA 22nd EDN - 4500-F B&D	1.0	0.52	1.84	0.85	0.88
12	Nitrate as NO_3	mg/l	APHA 22nd EDN - 4500- NO_3^- B	45	132	344	340	275
13	Ammonia as N-NH_3	mg/l	APHA 22nd EDN - 4500- NH_3 B&C	0.5	BDL(<0.05)	0.06	BDL(<0.05)	BDL(<0.05)
14	Phosphate as PO_4	mg/l	IS : 3025 Part 31-1988 (Reaff:2002)	Not Specified	0.03	0.11	3.09	0.11
15	Sodium as Na	mg/l	IS : 3025 Part 45-1993 (Reaff:2003)	Not Specified	150	1060	530	210
16	Potassium as K	mg/l	IS : 3025 Part 45-1993 (Reaff:2003)	Not Specified	14	37	17	11

17	Calcium as Ca	mg/l	IS : 3025 Part 40-1991 (Reaff:2003)	75	172	504	176	132
18	Magnesium as Mg	mg/l	APHA 22nd EDN-3500,Mg - B	30	73	321	107	46
19	Iron as Fe	mg/l	IS : 3025 Part 53-2003	0.3	0.45	0.05	BDL(<0.05)	0.24
20	Chemical Oxygen Demand	mg/l	IS:3025:Part-58:2006	Not Specified	16.2	10.7	12	18.5

BDL –Below Detectable Limit GW1-Sivakasi-Borewell, GW2 - Thiruvengadam - Borewell , GW3- Mannur – Borewell, GW4- Sankarankoil-Borewell.

S. No	Parameters	Unit	Test method	Limit as per IS 10500 : 2012	GW5	GW6	GW7	GW8
1	Colour	Hazen	APHA 22nd EDITION	5	3	Nil	Nil	Nil
2	Odour	-	APHA 22nd EDITION	Unobjectionable	No Odour Observed	No Odour Observed	No Odour Observed	No Odour Observed
3	pH at 25°C	-	IS : 3025 Part 11-1983 (Reaff: 2002)	6.5-8.5	7.84	7.50	7.34	7.33
4	Electrical Conductivity,	µS/cm	IS : 3025 Part 14-1984 (Reaff: 2002)	Not Specified	375	5870	2410	715
5	Turbidity	NTU	IS : 3025 Part 10-1984 (Reaff: 2002)	1	2.3	BDL(<0.5)	BDL(<0.5)	BDL(<0.5)
6	Total Dissolved Solids	mg/l	IS : 3025 Part 16-1984 (Reaff: 2003)	500	194	3642	1371	386
7	Total Hardness as CaCO3	mg/l	IS : 3025 Part 21-2009	200	116	2060	740	188
8	Total Alkalinity as CaCO3	mg/l	IS : 3025 Part 23-1986(Reaff:2003)	200	118	320	520	136
9	Chloride as Cl	mg/l	IS : 3025 Part 32-1988 (Reaff: 2003)	250	26	1162	352	70
10	Sulphate as SO_4	mg/l	APHA 22nd EDN-4500- SO_4^{2-} E	200	23	256	111	34
11	Fluoride as F	mg/l	APHA 22nd EDN - 4500-F B&D	1.0	0.47	0.89	1.16	0.65
12	Nitrate as NO_3	mg/l	APHA 22nd EDN - 4500- NO_3^- B	45	1.6	849	55	64
13	Ammonia as N-NH_3	mg/l	APHA 22nd EDN - 4500- NH_3 B&C	0.5	0.05	0.33	BDL (<0.05)	BDL (<0.05)
14	Phosphate as PO_4	mg/l	IS : 3025 Part 31-1988 (Reaff:2002)	Not Specified	0.11	0.09	1.73	0.08

15	Sodium as Na	mg/l	IS : 3025 Part 45-1993 (Reaff:2003)	Not Specified	28	370	205	59
16	Potassium as K	mg/l	IS : 3025 Part 45-1993 (Reaff:2003)	Not Specified	2.2	34	12	4.2
17	Calcium as Ca	mg/l	IS : 3025 Part 40-1991 (Reaff:2003)	75	26	464	180	37
18	Magnesium as Mg	mg/l	APHA 22nd EDN-3500,Mg - B	30	13	219	71	23
19	Iron as Fe	mg/l	IS : 3025 Part 53-2003	0.3	0.39	BDL (<0.05)	0.12	BDL (<0.05)
20	Chemical Oxygen Demand	mg/l	IS:3025:Part-58:2006	Not Specified	14.8	8.8	13.6	9.4

BDL-Below Detectable Limit GW5- Sivakasi Drinking Water, GW6- Panavadalichatram-Bore Well, GW7-Thiruthangal-Borewell, GW8-Kondanagaram –Borewell

BDL- Below Detectable Limit GW10 – Puliyankudi Drinking Water (Tamirabarani*),*G11- Mannur Drinking Water (Tamirabarani) GW12-Panavadalichatram Drinking Water (Tamirabarani)

S. No	Parameters	Unit	Test method	Limit as per IS 10500 : 2012	GW9	GW10	GW11	GW12
1	Colour	Hazen	APHA 22nd EDITION	5	Nil	Nil	2	1
2	Odour	-	APHA 22nd EDITION	Unobjectionable	No Odour Observed	No Odour Observed	No Odour Observed	No Odour Observed
3	pH at 25°C	-	IS : 3025 Part 11-1983 (Reaff: 2002)	6.5-8.5	7.74	7.66	7.33	7.84
4	Electrical Conductivity,	µS/cm	IS : 3025 Part 14-1984 (Reaff: 2002)	Not Specified	1390	104	146	276
5	Turbidity	NTU	IS : 3025 Part 10-1984 (Reaff: 2002)	1	BDL(<0.5)	BDL(<0.5)	1.5	0.8
6	Total Dissolved Solids	mg/l	IS : 3025 Part 16-1984 (Reaff: 2003)	500	783	58	79	152
7	Total Hardness as CaCO3	mg/l	IS : 3025 Part 21-2009	200	360	32	52	102
8	Total Alkalinity as CaCO3	mg/l	IS : 3025 Part 23-1986(Reaff:2003)	200	260	34	46	98
9	Chloride as Cl	mg/l	IS : 3025 Part 32-1988 (Reaff: 2003)	250	146	8.2	14.6	20
10	Sulphate as SO_4	mg/l	APHA 22nd EDN-4500- SO_4^{2-} E	200	81	5	5.2	10
11	Fluoride as F	mg/l	APHA 22nd EDN - 4500-F B&D	1.0	0.81	0.32	0.49	0.56

12	Nitrate as NO_3	mg/l	APHA 22nd EDN - 4500- NO_3^- B	45	129	2.1	2.2	1.5
13	Ammonia as N-NH_3	mg/l	APHA 22nd EDN - 4500- NH_3 B&C	0.5	BDL(<0.05)	BDL(<0.05)	0.07	0.08
14	Phosphate as PO_4	mg/l	IS : 3025 Part 31-1988 (Reaff:2002)	Not Specified	0.07	0.08	0.06	0.03
15	Sodium as Na	mg/l	IS : 3025 Part 45-1993 (Reaff:2003)	Not Specified	130	8.8	9.5	16.2
16	Potassium as K	mg/l	IS : 3025 Part 45-1993 (Reaff:2003)	Not Specified	9.7	1.2	BDL(<1)	BDL(<1)
17	Calcium as Ca	mg/l	IS : 3025 Part 40-1991 (Reaff:2003)	75	88	8.8	12.8	27
18	Magnesium as Mg	mg/l	APHA 22nd EDN-3500,Mg - B	30	34	2.4	5	8.3
19	Iron as Fe	mg/l	IS : 3025 Part 53-2003	0.3	BDL(<0.05)	BDL(<0.05)	0.26	0.43
20	Chemical Oxygen Demand	mg/l	IS:3025:Part-58:2006	Not Specified	14.1	4.3	10.2	12.7

BDL –Below Detectable Limit, GW13- Rajapalayam Iyyanarappan Falls, GW14 – Rajapalayam Borewell water.

S. No	Parameters	Unit	Test method	Limit as per IS 10500 : 2012	GW13	GW14
1	Colour	Hazen	APHA 22nd EDITION	5	Nil	Nil
2	Odour	-	APHA 22nd EDITION	Unobjectionable	No Odour Observed	No Odour Observed
3	pH at 25°C	-	IS : 3025 Part 11-1983 (Reaff: 2002)	6.5-8.5	7.85	7.20
4	Electrical Conductivity,	µS/cm	IS : 3025 Part 14-1984 (Reaff: 2002)	Not Specified	189	1630
5	Turbidity	NTU	IS : 3025 Part 10-1984 (Reaff: 2002)	1	BDL(<0.5)	1.8
6	Total Dissolved Solids	mg/l	IS : 3025 Part 16-1984 (Reaff: 2003)	500	104	932

7	Total Hardness as CaCO3	mg/l	IS : 3025 Part 21-2009	200	90	260
8	Total Alkalinity as CaCO3	mg/l	IS : 3025 Part 23-1986(Reaff:2003)	200	88	180
9	Chloride as Cl	mg/l	IS : 3025 Part 32-1988 (Reaff: 2003)	250	3.7	160
10	Sulphate as SO_4	mg/l	APHA 22nd EDN-4500- SO_4^{2-} E	200	6	219
11	Fluoride as F	mg/l	APHA 22nd EDN - 4500-F B&D	1.0	0.78	3.16
12	Nitrate as NO_3	mg/l	APHA 22nd EDN - 4500- NO_3^- B	45	BDL(<1)	133
13	Ammonia as NH_3	mg/l	APHA 22nd EDN - 4500- NH_3 B&C	Not Specified	BDL(<0.05)	0.23
14	Phosphate as PO_4	mg/l	IS : 3025 Part 31-1988 (Reaff:2002)	Not Specified	0.10	0.42
15	Sodium as Na	mg/l	IS : 3025 Part 45-1993 (Reaff:2003)	Not Specified	4.8	210
16	Potassium as K	mg/l	IS : 3025 Part 45-1993 (Reaff:2003)	Not Specified	BDL(<1)	13
17	Calcium as Ca	mg/l	IS : 3025 Part 40-1991 (Reaff:2003)	75	19	56
18	Magnesium as Mg	mg/l	APHA 22nd EDN-3500,Mg - B	30	10.2	29
19	Iron as Fe	mg/l	IS : 3025 Part 53-2003	0.3	0.05	0.21
20	Chemical Oxygen Demand	mg/l	IS:3025:Part-58:2006	Not Specified	8.2	13.7

Table 4.6-Surface Water Quality Results (Tamirabarani River)

S. No	Parameters	Unit	Test method	Limits as per IS 10500:2012	SW1
1	Colour	Hazen	APHA 22nd EDITION	5	7
2	Odour	-	APHA 22nd EDITION	Unobjectionable	No Odour Observed
3	pH at 25°C	-	IS : 3025 Part 11-1983 (Reaff: 2002)	6.5-8.5	7.20
4	Electrical Conductivity,	µS/cm	IS : 3025 Part 14-1984 (Reaff: 2002)	Not Specified	148
5	Turbidity	NTU	IS : 3025 Part 10-1984 (Reaff: 2002)	1	10.6
6	Total Dissolved Solids	mg/l	IS : 3025 Part 16-1984 (Reaff: 2003)	500	79
7	Total Hardness as CaCO3	mg/l	IS : 3025 Part 21-2009	200	52
8	Total Alkalinity as CaCO3	mg/l	IS : 3025 Part 23-1986(Reaff:2003)	200	48
9	Chloride as Cl	mg/l	IS : 3025 Part 32-1988 (Reaff: 2003)	250	12
10	Sulphate as SO_4	mg/l	APHA 22nd EDN-4500-SO_4^{2-} E	200	6.6
11	Fluoride as F	mg/l	APHA 22nd EDN - 4500-F B&D	1.0	0.50
12	Nitrate as NO_3	mg/l	APHA 22nd EDN - 4500- NO_3^- B	45	1.8
13	Ammonia as NH_3	mg/l	APHA 22nd EDN - 4500- NH_3 B&C	0.5	0.07
14	Phosphate as PO_4	mg/l	IS : 3025 Part 31-1988 (Reaff:2002)	Not specified	0.08
15	Sodium as Na	mg/l	IS : 3025 Part 45-1993 (Reaff:2003)	Not specified	9.4
16	Potassium as K	mg/l	IS : 3025 Part 45-1993 (Reaff:2003)	Not specified	1
17	Calcium as Ca	mg/l	IS : 3025 Part 40-1991 (Reaff:2003)	75	12
18	Magnesium as Mg	mg/l	APHA 22nd EDN-3500,Mg - B	30	5.3
19	Iron as Fe	mg/l	IS : 3025 Part 53-2003	0.3	0.72

20	Anionic Surfactants as MBAS	mg/l	APHA 22nd EDN- 5540 C	0.2	BDL(<0.025)
21	Dissolved Oxygen as O_2	mg/l	IS:3025:Part-38:1989 (Reaff:2003)	Not specified	6.4
22	Chemical Oxygen Demand	mg/l	IS:3025:Part-58:2006	Not specified	24
23	BOD @ 27 C for 3 days	mg/l	IS : 3025 Part 17-1984 (Reaff: 2002)	Not specified	BDL(<2)
24	Total Suspended Solids	mg/l	IS:3025:Part-44:1993 (Reaff:2003)	Not specified	9
25	Total Coliforms	MPN/100ml	IS 1622 (1981) (Reaff – 2003)	Not specified	542
26	Faecal Coliforms	MPN/100ml	IS 1622 (1981)(Reaff – 2003)	Not specified	94

4.7.5 Observations

A) Ground water resources

- The pH of ground water in the study area varies between 6.81 to 7.85 and Conductivity varies from 104 to 9770 µS/cm.
- TDS values were found to be from 58 to 5960 mg/l and Total Hardness varied from 32 – 2580 mg/l. This indicates that water in the study area were very hard in nature. The Total alkalinity also varies from 34 to 520 mg/L.
- Sodium and potassium are naturally occurring elements of groundwater. Industrial and domestic wastes also add sodium to groundwater. It is one of the major contributors to salinity of water. The concentration of sodium in the studied samples varied from 4.8 to 1060 mg/l.
- The chloride content in the studied area ranged from 3.7 - 2104 mg/l. The sulphate, nitrate and fluoride content in the ground water are found to be within the IS standards in all the samples.

B) Surface Water Resources

- The pH of ground water in the study area is 7.20 and Conductivity is 148 µS/cm.
- TDS values were found to be 79 mg/l and Total Hardness found to be52 mg/l. This indicates that water in the study area was hard in nature and it is observed that it lies within the standards. The Total alkalinity found to be 48 mg/L.
- Total Coliform count is observed in study area range is 542 (MPN/100ml which exceeds the drinking water (IS) standards.
- Faecal Coliforms count is observed in study area range is 94 (MPN/100ml), which exceeds the drinking water (IS) standards.

4.8 Land Environment

It is essential to determine the type & quality of soil in the study area and identify the current impacts of urbanization on soil quality and also predict probable impacts due to the proposed plant. Accordingly, a study of assessment of the baseline soil quality was carried out.

For studying soil quality of the region, sampling locations were selected to assess the existing soil conditions in and around the 'Project area based on various land use conditions. The physical and chemical concentrations were determined. The samples were collected from different specified depths viz., 30cm, 60cm and 100cm

The present study of the soil quality establishes the baseline characteristics and this will help in future in identifying the incremental concentrations if any, due to the operation of the proposed plant. The sampling locations have been identified with the following objectives;

- To determine the baseline soil characteristics of the study area.
- To determine the impact of proposed project on soil characteristics and
- To determine the impact on soils more importantly loss of fertility from agricultural productivity point of view.

Various locations within 10-km radius of the plant site were selected for soil sampling. At each location, soil samples were collected from three different depths viz., 30cm, 60cm, and 100cm below the surface. The samples were analyzed for physical and chemical

characteristics. The samples have been analyzed as per the established scientific methods for physico-chemical parameters.

4.8.1 Soil Characteristics

a) Soil Type

Soil type and its fertility of an area are essential to plan for cropping. Soils are primarily derived from parent rocks. The colour, texture and mineral content are normally used to classify the soil. The soil in the study area is classified into 3 types. They are as follows.

S. No	Soil Classification
1	Deep, moderately well drained, calcareous, clayey soils
2	Very shallow somewhat excessively drained, gravelly loam soils
3	Moderately deep, moderately well drained, gravelly clay soils

Sandy clay soil type is present in of the study area.

b) Soil quality

To assess the soil quality in the study area, soil sample was collected and analyzed for physical and chemical parameters as per the standard methods. The sampling locations are given in **Figure 4.7**and the results are given in **Table 4.7**.

Table 4.7-Soil Analysis Results

S. NO	Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9
1	pH	8.51	8.66	8.37	7.85	8.54	8.46	7.92	8.17	8.52
2	Electrical Conductivity, mS/cm	0.154	0.366	0.132	0.196	0.315	0.484	0.284	0.168	0.401
3	Available Nitrogen, mg/kg	26.8	41.4	36.2	27.3	47.2	61.4	15.6	22.8	53.6
4	Available Phosphorous, mg/kg	67.1	92.3	82.5	45.2	54.1	112.4	36.1	104.1	93.7
5	Available Potassium, mg/kg	254	301	173	154	218	318	272	194	331
6	Exchangeable Calcium as Ca, m.eq/100g	12.1	15.7	10.4	8.54	12.8	17.3	7.32	9.68	16.2
7	Exchangeable Magnesium as Mg, m.eq/100g	5.42	6.71	4.72	5.16	6.32	7.35	3.96	4.74	5.62
8	Exchangeable Sodium as Na, m.eq/100g	0.82	1.14	0.71	0.64	1.35	1.64	0.96	0.82	1.25
9	Organic matter (%)	1.38	1.61	0.97	0.86	1.76	1.37	1.12	1.17	2.01
10	Texture Classification	Clay	Clay	Clay	Sandy Clay	Clay	Clay	Sandy Clay Loam	Clay	Clay
11	Sand (%)	24.7	27.1	21.6	48.6	31.6	27.3	51.3	23.6	33.7
12	Clay (%)	56.6	63.7	58.4	36.8	64.3	61.4	27.2	57.1	47.2
13	Silt (%)	18.7	9.2	20	14.6	4.1	11.3	21.5	19.3	19.1

S1- MANNUR, S2- SIVAKASI , S3- TP KONDANAGARAM S4- PANAVADALI CHATRAM , S5- THIRUVENGADAM, S6- RAJAPALAYAM, S7- PULIYANKODI, S8- THIRUTHANGAL, S9- SANKARANKOIL

Figure 4.7-Soil Sampling Locations

4.8.2 Discussion

The pH indicates that the soils in the study areas are basic in nature, with the pH varying in the range of 7.85 to 8.66. The Electrical Conductivity was observed in the range of 0.132-0.484 mS/cm.

The Nitrogen values are in the range of 15.6 – 61.4 mg/kg indicating that soils have very low Nitrogen levels. The Phosphorous values are in the range of 36.1 – 112.4 mg/kg indicating that soils have an average Phosphorous level. The Potassium values range between 154 – 331 mg/kg, which indicate that the soils have better quantity of Potassium. The Organic matter (%) values range between 0.86 – 2.01. The soil from the study area shows that they are less fertile.

4.9 Biological Environment

The existing Flora and Fauna in the study area is mentioned below. As per Botanical Survey of India records and available published literature pertaining to the study area and current detailed study of project site, no threatened, endangered and rare plant species were observed from the study area.

The major aquatic component of the project area represented by the Tamirabarani Dam is rich in floral and faunal diversity. The macro faunal composition in the project area is found to have a rich variety of aquatic life. The range of fauna recorded includes the benthic, column and surface feeders. **The flora and fauna detail is given in table 4.8.**

Table 4.8-Details of flora and fauna

Scientific Name	Local Name/English Name
Flora	
Azadirachta indica	Neem Tree
Prosopis juliflora	Karuvelam maram
Arecaceae	Palm tree
Ficus religiosa	Arasa maram
Ficus benghalensis	Banyan tree
Hibiscus rosa-sinensis	Chembaruthi
Fauna	
Funambulus sp	Squirrel
Pavo cristatus	Peacock
Rattus norvegicus	Field mouse
Rana hexadactyla	Frog
Rhopalocera	Butterfly
Megalaima merulinus	Indian Cuckoo
Passer domisticus	House Sparrow
Corvus splendens	Crow

4.9.1 Aquatic Ecology

Ecology is the scientific study of the interactions of organisms with themselves and the abiotic and biotic factors of the surrounding environments. The study was conducted in three seasons. Therefore, any change in the natural environment can alter the habitat fragmentation, which leads to change/loss of biodiversity as the species specific interaction and their food chain link gets widely impacted in response to the stress generated from the change in physical, chemical and biological environment.

Tamirabarani river flow continuous thought the year, it is one of the most fish-rich river in the world where the river is dominated by more than 16 native Snakehead species. It is estimated that nearly 669 fish species were found in the river. Fish ecosystem is flourished in the river and fishes present in this river are vibrant in color and healthy in nature. The dominant fish in the project site area are Catla, Puntius malus, Anabas scadens, Labeo and calbasu.

From the secondary data of the studies was carried out in Ambasamundram and Thiruppudaimaruthur. These studies were conducted upstream side of Kondanagaram site area within 10 km distance. The fish detail is given in **Table 4.9.**

Table 4.9- Fish species observed /reported from the river Tamirabarani in study area

S.No	Family /Fish species
1	*Puntius ticto*
2	*Puntius faciatus*
3	*Puntius dorsalis*
4	*Borbodes or Puntius carnaticus*
5	*Silurus wynaadensis*
6	*Nemacheilus tringularis*
7	*Nemacheilus pulchellus*
8	*Lepidocephalus thermalis*
9	*Mystus vitatus*
10	*Mystus montanus*
11	*M.armatus*
12	*Channa orientalis*
13	*Channa gachua*
14	*Glossogobius giuris*

4.9.2 Aquatic Micro -Flora and Fauna

The composition of phytoplankton, Phytobenthosand zooplankton of a particular aquatic ecosystem are indicators of environmental stress. The phytoplanktons constitute bulk of primary producers and are the base of food chains in any water body.

The common species among algae during monsoons are (Actinastrum hantzchii), Chlorogonium elongatum, Cosmarium granatum, Scenedesmusquadricauda and Crucigenia tetrapedia are the common algae reported. The diatoms like Aphanocapsa, Arthrospira platensis, Chroococcus gigantius are found throughout the period Achnanthus inflata, Amphora ovalis, Synedra ulna and Tabellaria flocculosa are observed abundantly. The detail of phytoplankton is given in **Table 4.10**.

Table 4.10-Details of Phytoplankton

Phytoplankton Taxon	**Phytoplankton Taxon**
Chlorophycae	**Euglenophycae**
Actinastrum sp.	Euglena vedinas sp.
Ankistrodesmus sp.	Lepocinclis sp.
Crucigenia sp.	Chlamydomonas sp.
Closterium siamensis	*Trachelomonas sp*
Dactylococcus sp	*Volvox* aureus
Chlorococcum sp.	**Bacillariohycae**
Characium sp.	*Hydrodictyon sp*
Cholorogonium sp.	Navicula sp.
Cosmarium sp.	Centronella sp.
Zygnema sp.	Synedra sp.

4.9.3 Phytobenthos

Most of these phytobenthos species are found entangle form with filamentus algae like *Spirogyra, Ulothrix, Oedogonius, Cladophora* and *Zygnema* species which are forming mats on the river bed. The diversity of phytobenthos observed in the Tamirabarani River. The detail of Phytobenthos is given in **Table 4.11**.

Table 4.11- Details of Phytobenthos

Phytobenthos Taxon	Phytobenthos Taxon
Closterium acutum	*Botryococcus sp.*
Closteridium sp.	Fragillaria sp.
Cosmarium sp.	Synedra sp.
Cladophora sp.	Navicula sp.
Euastrium sp.	*Achnanthus inflata*
Zygnema sp.	Nitzeschia sp.
Chara spp.	Trabellaria sp.
Nitella spp.	Amphora sp.
Ulothrix sp.	*Kirchneriella sp*
Spirogyra sp.	*Anacystis* sp.
Microspora sp.	*Oscillatoria* sp.

4.9.4 Zooplanktons

Zooplankton population of the river comprised generally Protozoans Rotifers, Cladoceran and Copepods. Among them, commonly occurring zooplankters were Arcella sp was found common. The diversity of **Zooplanktons** observed in the Tamirabarani river. The detail of Zooplanktons is given in **Table 4.12**.

Table 4.12-Details of Zooplanktons

Zooplanktons Taxon	Zooplanktons Taxon
Protozoa	**Copepoda**
Arcella discoida	Cyclops spp
Ceratium sp	Eucyclopes
Diffuzia sp.	**Cladocerans**
Paramecium sp.	Daphinia corinata
Rotifera	Ceriodiaphnia reticulate
Asplanchnopus sp	Daphinia pulex
Brachionus sp.	**Ostracoda**
B. calciflors	Heterocypris sp
Polyarthra vulgaris	Cypris sp
Trichocera longiseta	Candona sp

4.9.5 Benthic Invertebrates

Freshwater insects have important roles in the ecology of running waters. They are vital for riparian and flood plain food webs, processing organic matter and transporting energy along stream channels, laterally to the flood plains and even vertically down into the stream bed. The review of literature indicates that the river invertebrates, especially insects, which form bulk of the diversity in the Tamirabarani river basins have been thoroughly documented by many workers.

The presence of high proportion of collector-filterers and low proportion of shredders is probably related to the abundant of organic matter, which is supplemented by fine Particulate allochthonous inputs and algae that usually offer considerable nutritional value. The detail of benthic invertebrate communities is given in **Table 4.13.**

Table 4.13- Details of benthic invertebrate communities

Order	**Family**	**Genus**	**Habits**
Ephemeroptera	Isonychidae	*Isonychia sp*	Collector-filter
	Heptageniidae	*Thalerosphyrus sp.*	Grazer
		Cinygmina sp.	Collector
		Epeorus sp	Collector
	Leptophlebiidae	*Choroterpes alagarensis*	Shredder
		Choroterpes sp	Scrapers
		Petersula sp.	Collector
Trichoptera	Hydropsychidae	*Hydropsyche sp.*	Collector-filters
		Cheumatopsyche sp.	collector
Plecoptera	Perlidae	*Neoperla sp.*	Predator
		Naucoris sp.	Predator
Hemiptera	Corixidae	*Micronecta sp*	Herbivores
	Nepidae (ranatra)	*Ranatra elongata*	
	Gerridae	*Gerris sp*	Predator
Lepidoptera	Pyralidae	*Aquatic pyralid moth*	
Coleoptera	Psephenidae	*Eubrianax sp.*	Scrapers
Diptera	Tipulidae	*Hexatoma sp.*	Predator
	Chironomidae	*Chironomus sp*	Collector
	Culicidae	*Culex mosquitoes*	
Megaloptera	Coridalidae	*Coridalus sp.*	Predator
	Thiaridae	*Thiara sp.*	

4.10 Socio-Economic Environment

Review of secondary data (District Census Statistical Handbooks - 2011) with respect to population, occupation structure and infrastructure facilities available for the study area. Socio-Economic status of the population is an indicator for the development of the region. Any developmental project of any magnitude will have a bearing on the living conditions and on the economic base of population in particular and the region as a whole. Similarly, the proposed activities will have its share of socio-economic influence in the study area. The section delineates the overall appraisal of society relevant attributes. The data collection for evaluation of impact of proposed project on socioeconomic aspects in the study area has been done through primary household survey method and through the analysis of secondary data collected for the given study area. The survey of Environmental screening form is enclosed in **Annexure VII.** Population, literate details, sanitation facility and waste management of the study area is furnished below. The population detail of the study is given in **Table 4.14**.

Table 4.14-Population Details of the Study Area (As per Census 2011)

S. No	Municipality/ Town Panchayat	Total no. of Households	Population Details			Literates		Workers		SC Population	ST Population
			Total	Male	Female	Male	Female	Main	Marginal		
Tirunelveli District											
1	Sankarankoil Municipality	95446	350144	172965	177179	131234	105688	164743	18774	93160	518
2	Puliankudi Municipality	17209	66034	32843	33191	25348	20598	27671	2264	11634	173
3	Thiruvenkadam Town Panchayat	2368	8337	4144	4193	3234	2632	3697	486	2281	78
Virudhunagar District											
4	Rajapalayam Municipality	100543	347668	173529	174139	138189	116879	148935	15103	76569	545
5	Thiruthangal Municipality	15424	55362	27676	27686	21660	18140	25291	1868	11567	103
6	Sivakasi Municipality	117312	426753	211880	214873	165056	140445	198020	12341	79775	515

	Name of Village	Total Population	Literates	% of Literate	Illiterates	Workers	% Workers	Marginal Workers	Non Workers
Thirunelveli	Sankarankoil Municipality	350144	236922	67.66	28754	93678	26.75	18774	545
	Puliankudi Municipality	66034	45946	69.57	40176	11807	17.88	2264	285
	Thiruvenkadam Town Panchayat	8337	5866	70.36	4942	2359	28.29	486	174
Virudhunagar	Rajapalayam Municipality	347668	255068	73.36	58751	77114	22.18	15103	288
	Thiruthangal Municipality	55362	39800	71.89	28950	11670	21.07	1868	751
	Sivakasi Municipality	426753	305501	71.58	33513	80290	18.81	12341	336

4.11 Status of Sanitation

The sanitation status of five Municipality and one town panchayat is given below.

a) **Rajapalayam Municipality:**

Rajapalayam is a special Grade Municipality in Virudhunagar District. This Municipality has 42 Administrative Wards. All 962 Streets has Door-to-Door garbage collection system. Hotels, Restaurants and marriage halls generate around **1.5** MT waste and it is also removed on daily basis through separate lorry. Bio-Medical Waste is collected as per Norms already fixed by TNPCB, through Private Agency under the supervision of Pollution control Board, Virudhunagar. Currently there is no underground sewerage systems developed and the sewage is being sent to septic tank with soak pit.

b) **Puliyankudi Municipality:**

Puliyankudi is a Grade – II Municipal town located in Tirunelveli District. The total population of the municipality is 66015. This Municipality has **42** Administrative Wards. The municipal solid waste generation per day is **15** MT, these waste are collected by Door-to-Door garbage collection system. Puliyankudi municipality has 26 public toilets, these are maintained by lessee and self help group (SHG). Individual toilets are being constructed under Swachh Bharat Abhiyan scheme. Currently there is no underground sewerage systems developed and the sewage is being sent to septic tank with soak pit.

c) **Sankarankovil Municipality:**

Sankarankovil Municipal town is located in Tirunelveli District. The total population is 57315 with 20625 households. This Municipality has 30 Administrative Wards. The municipal solid waste generation per day is 22 MT, these waste are collected by Door-to-Door garbage collection system and stored in municipality compost yard. Sankarankovil municipality has public toilets, and is maintained by lessee and self help group (SHG). Totally 2348 Nos Individual toilets are being constructed under Swachh Bharat Abhiyan scheme. Currently there is no underground sewerage systems developed and the sewage is being sent to septic tank with soak pit.

d) **Thiruthangal Municipality:**

Thiruthangal Municipal town is located in Virudhunagar District. The total population is 55343 with 21142 households. This Municipality has 21 Administrative

Wards. The municipal solid waste generation per day is 66 MT, these waste are collected by Door-to-Door garbage collection system and stored in municipality compost yard(7Acre 37.5 cent). Thiruthangal municipality has public toilets, and are maintained by lessee and self help group (SHG). Individual toilets are being constructed under Swachh Bharat Abhiyan scheme. Currently there is no underground sewerage systems developed and the sewage is being sent to septic tank with soak pit.

e) **Sivakasi Municipality**

Sivakasi Municipal town is located in Virudhunagar District. The total population is 71064 with 20230 households. This Municipality has 33 Administrative Wards. The municipal solid waste generation per day is 40 MT, these waste are collected by Door-to-Door garbage collection system and stored in municipality compost yard at Paraipatti (5.36 Acres) and Pernaickanpatti (9.14 Acres). Currently there is no underground sewerage systems developed and the sewage is being sent to septic tank with soak pit.

f) **Thiruvenkadam Town Panchayat**

Tiruvenkadam is a Town Panchayat city in Tirunelveli District with a population of 8337. The municipal solid waste generated is collected by Door-to-Door garbage collection system and stored in municipality compost yard. Currently there is no underground sewerage systems developed and the sewage is being sent to septic tank with soak pit.

The various environmental attributes of the study area has been analyzed and it ensures that the proposed project does not affect any sensitive areas. The water quality of Tamirabarani River was observed to be potable. It is also found that the Tamirabarani River is feasible for drawl of required amount of water for this proposed project. As per 2011 census the population, sanitary status and solid waste management facilities of the project area has been studied.

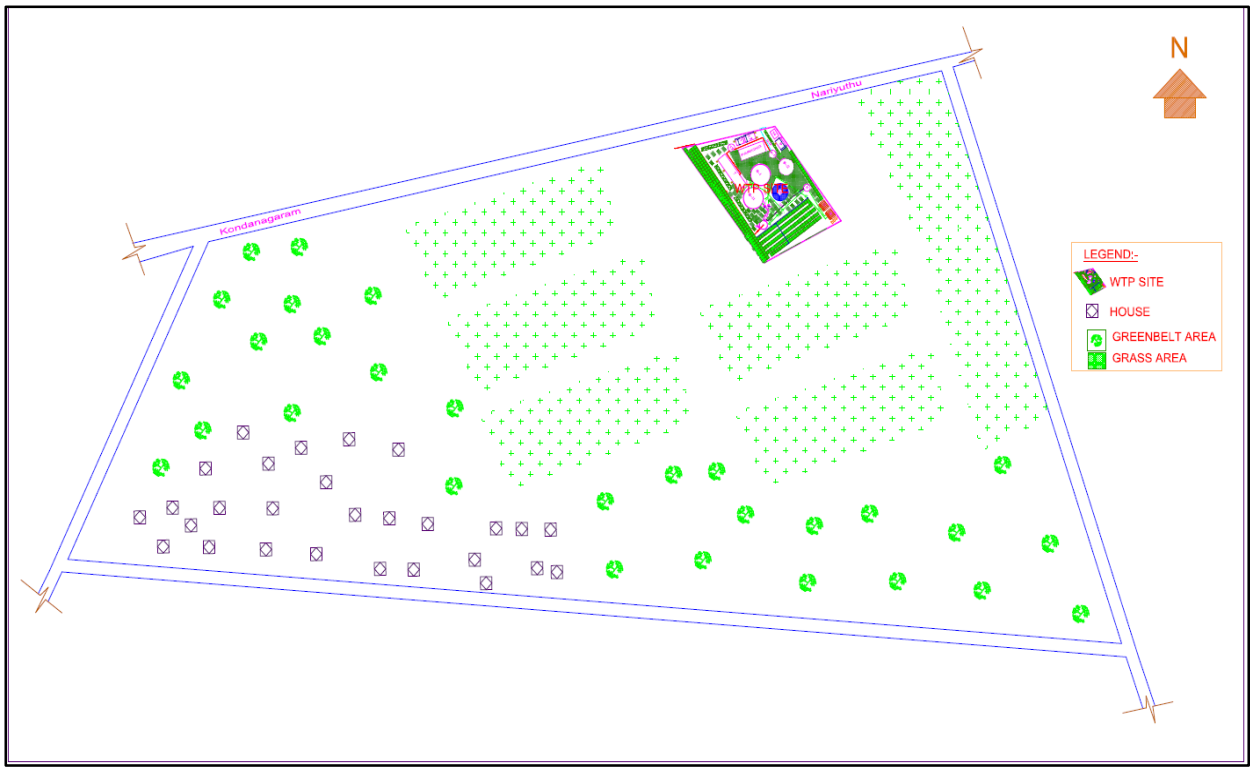
4.12 Description of Sites of Project Components

a) Head work

The head work is located in Tamirabarani River and upstream of check dam. This head work is situated near to the existing head work. Foot carrying bridge is total span of 112.9m in which 102.9m is in water and 10m in surface. The level of the hard rail from the average ground level is about 9.1m. The foot bridge is width 3.5m. The Raw water main diameter is 914*8mm MS pipe. The residential area is located in 500m from the head work.

b) Treatment Plant (Kondanagaram)

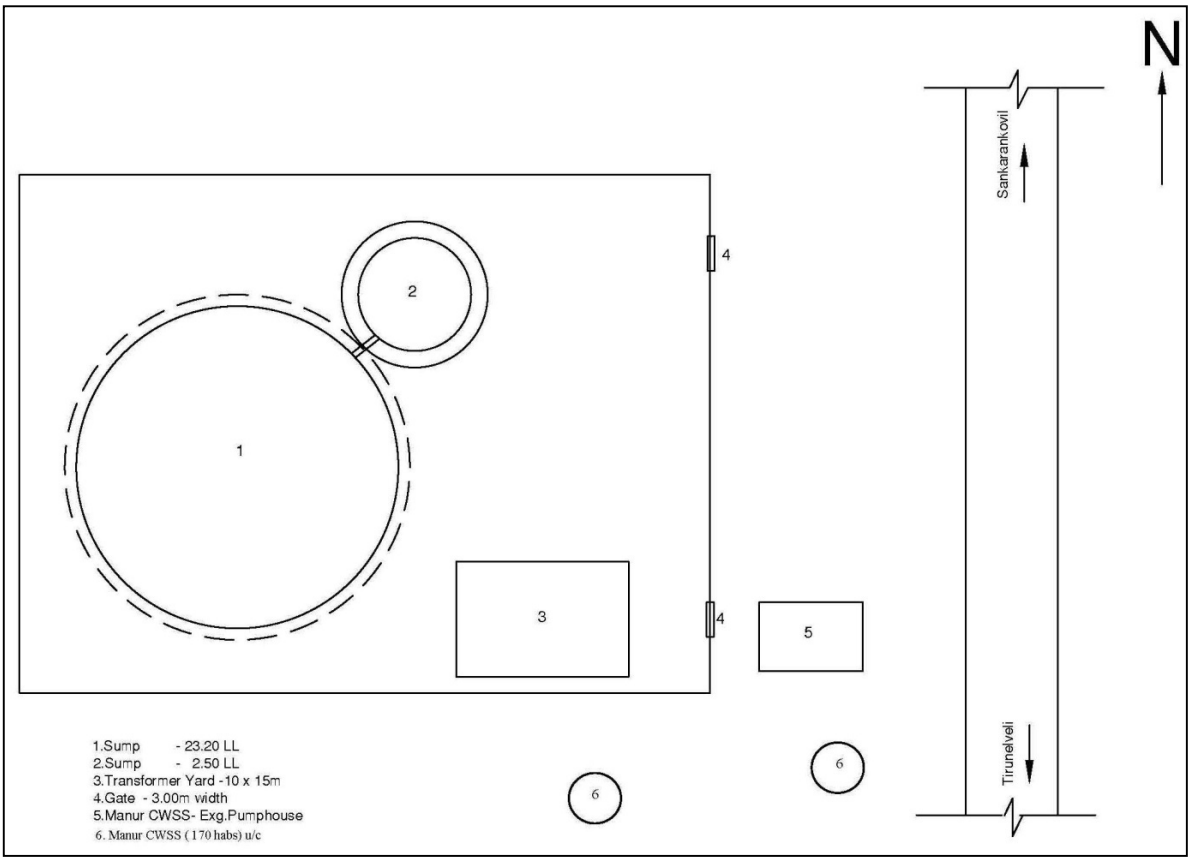
Kondanagaram is a Village in Manur Taluk in Tirunelveli District of Tamil Nadu State, India. It is located 8 km towards west from District head quarters Tirunelveli 22 km from Manur. Water treatment plant of capacity 46.08 MLD will be provided in the Kondanagaram village. It is located about 3.9km from the head work. The residential area is located in 300m from the treatment plant. Land use classification is Meikkal (Grazing) Poromboke.



FEATURE	DETAILS
Site location	8°42'37.03"N, 77°35'32.84"E
Above mean sea level in m	45 m
Population of the village Kondanagaram	1252
Nearest city	Tirunelveli
Nearest highway	SH 41 A -Tirunelveli- Pottalpudur road

c) Booster Station I (Manur)

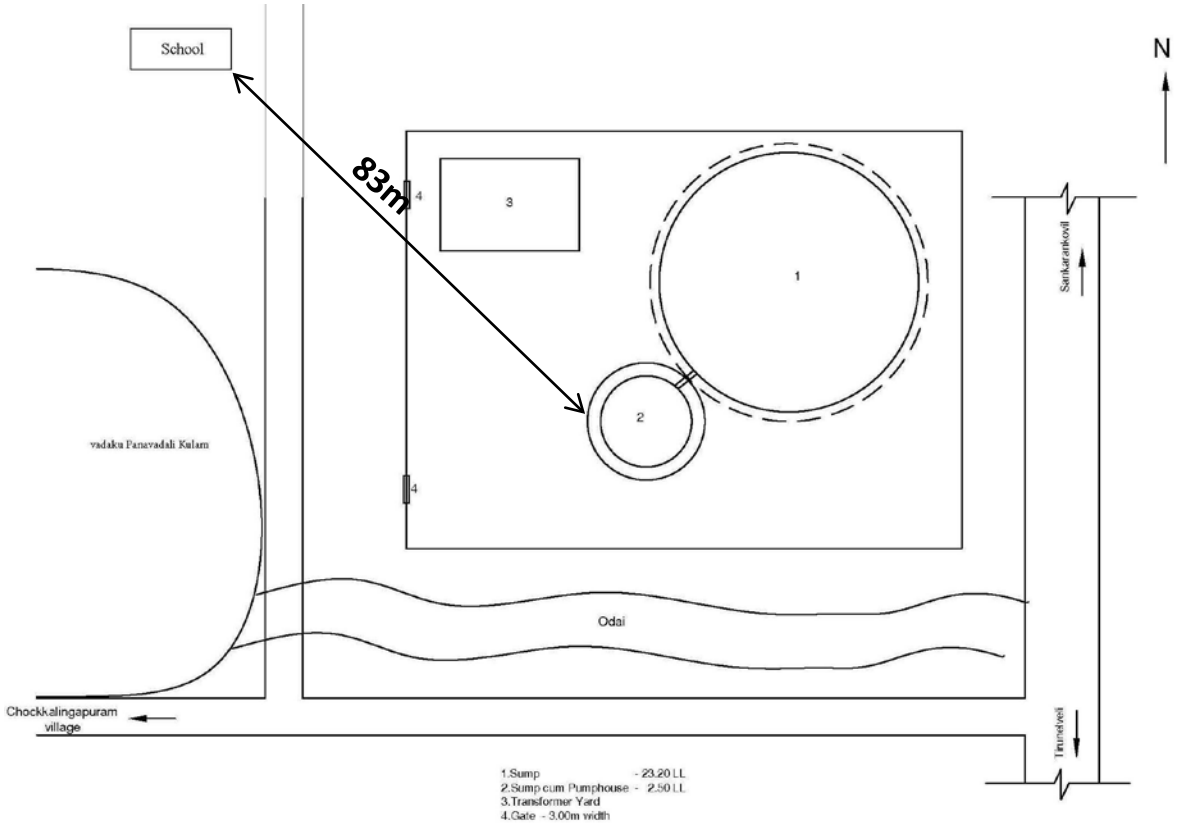
Manur is a City in Manur Taluk in Tirunelveli District of Tamil Nadu State, India. It is located 17 km towards North from District headquarters at Tirunelveli. It is a Taluk head quarter. It is proposed to construct 23.2 LL capacity sump and 2.5LL sump cum pump house. Already exiting sump is located near to the booster station. The site belongs to Manur Village Panchayat. The residential area is located in 200m from the booster station.



FEATURE	DETAILS
Site location	$8^{0}72'84.86"$ $77^{0}68'77.38"$
Above mean sea level in m	99 m
Population of the village Manur	2176
Nearest city	Tirunelveli
Nearest highway	SH 41 Ramanathapuram-Tirunelveli-road

d) Booster Station II (Padavalichathram)

Vadakku Panavadali is a small Village/hamlet in Melaneelithanallur Taluk in Tirunelveli District of Tamil Nadu State, India. It comes under Vadakkupanavadali Panchayat. It is located 51 KM towards North from District head quarters Tirunelveli. It is proposed to construct 23.2 LL capacity sump cum pump house. This is a Kulam poromboke site. The residential area is located in 200m from the booster station. The government school is 100m and village service centre is 80m located from the booster station.

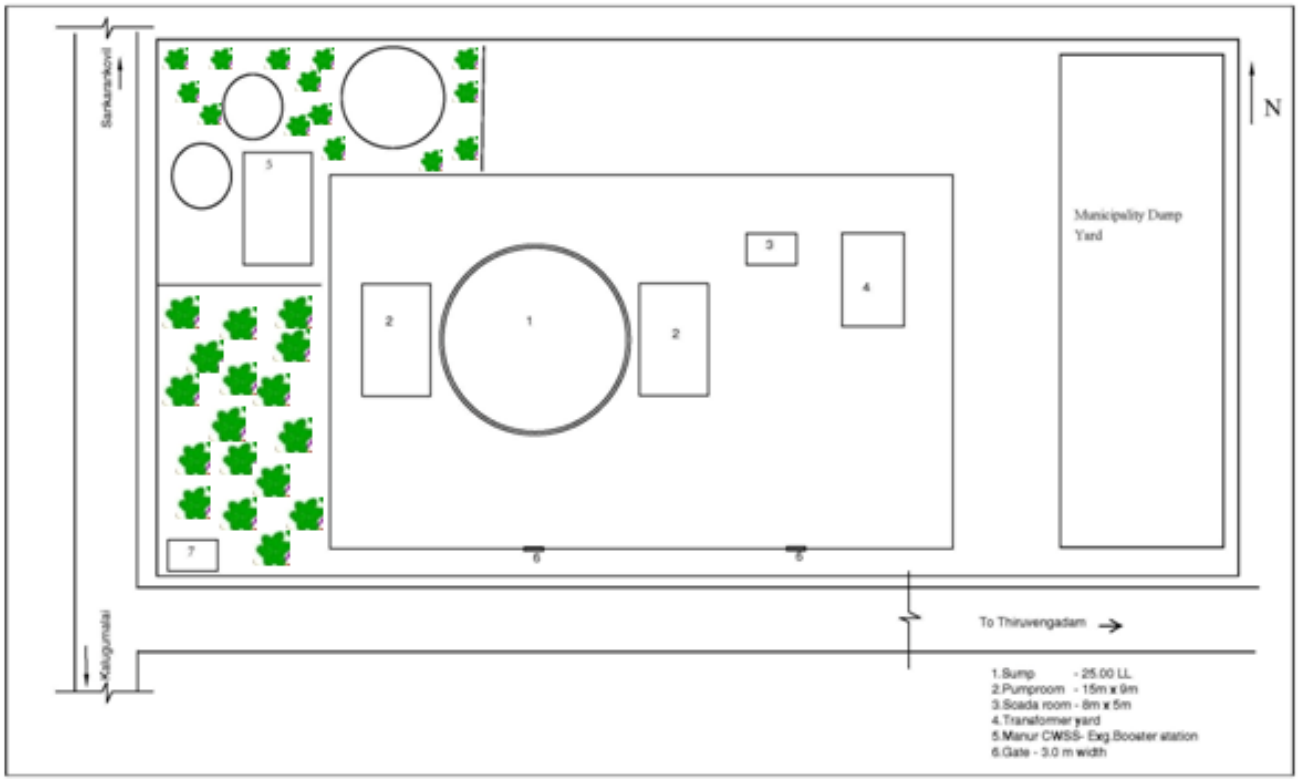


FEATURE	DETAILS
Site location	9°02'36.95"N 77°36'25.93"E
Above mean sea level in m	126 m
Population of the village Vadakku Panavadali	5671
Nearest city	Sankarankovil
Nearest highway	SH 41 Ramanathapuram-Tirunelveli-road

e) Booster Station III (Sankarankovil)

It is situated at Tirunelveli district and 56 km away from Thirunelveli City. Sankarankovil is the second largest town in the district is a second largest municipality in the Tirunelveli district. It is situated at Tirunelveli district and 56 km away from Thirunelveli City. Sankarankovil is the second largest town in the district. Booster sump of 25.70LL capacity is proposed to be established in this site. The site identified is part of the existing dump site belonging to Sankarankoil Municipality. The extent required is about 1.5acreas. It was suggested to TWAD Board to locate the booster station in the extent adjacent to the existing booster station. The residential area is located in 120m from the booster station. Sankarankoil Municipality was requested to clear the solid waste from the site. Also the earmarked area will be fenced and any further dumping will be stopped.

FEATURE	DETAILS
Site location	9°10'45.27"N 77°31'51.35"E
Above mean sea level in m	159 m
Population of the village Sankarankovil	53606
Nearest city	Tirunelveli
Nearest highway	SH 41 Ramanathapuram-Tirunelveli-road



f) SUMPS AND SERVICES RESERVOIRS

The clear water sumps and service reservoir are located in 5 municipalities (Sankarankoil, Puliankudi, Rajapalayam, Sivakasi & Thiruthangal) and one town panchayat (Thiruvenkadam). The number of existing service reservoir is 33 nos and proposed service reservoir is 22 nos.

5. ENVIRONMENTAL IMPACT ANALYSIS

5. 1 INTRODUCTION

Environmental Impact can be defined as "any alteration of environmental conditions or creation of a new set of environmental conditions, adverse or beneficial, caused or induced by the action or set of actions under consideration". Generally, environmental impacts can be classified as primary or secondary impacts. Primary impacts are those, which are attributed directly by the project while secondary impacts are those, which are induced by primary impacts and include the associated investments and changed patterns of the social and economic activities by the action.

This section identifies and assesses the potential changes in the environment that could be expected from the proposed project. The impacts have been predicted for the proposed activities assuming that the impact due to the existing activities has already been covered under base line environmental monitoring and continue to remains same till the operation of the project. The proposed project activities would create impact on the environment in two distinct phases i.e., construction and operation phases. Impacts are identified, predicted and evaluated based on the analysis of the information collected from the following:

- Project information (as discussed in Chapter-2) and
- Baseline information and site visits of the study area (as discussed in Chapter-3)

This section also describes mitigation measures, which have been suggested for the adverse impacts likely to be caused due to activities of both construction and operation phases of the project.

The identification of likely impacts during construction and operational phases of the proposed project has been done based on likely activities having their impact on one or another environmental parameters. The details of the activities and their impacts have been worked out in the following sections.

5.2 IDENTIFICATION OF LIKELY IMPACTS

Every activity and operation has either adverse or beneficial impacts on the environmental. The environmental impact identification has been done based on proposed project activities. All the activities from construction phase to operational phases of the project have been broadly covered, which is given in **Table 5.1** and **5.2**. The

activities and operations are considered on the basis of proposed project as described in the project description **Chapter 2.**

Table 5. 1- Activity-Impact Identification Matrix for Construction Phase

Construction phase		Potential impacts													
Main Activities	**Sub Activities**	**Land use**	**Landscape**	**Land/Soil environment**	**Surface Ground water**	**Water Quality**	**Air Quality**	**Solid waste generation**	**Ambient Noise level**	**Traffic and transport**	**Resource use (Energy)**	**Ecology**	**Socio – economic**	**Culture/ Heritage**	**Agriculture in the surroundings**
Site Preparation	Site Clearing & Cleaning Ground leveling Waste handling and its transportation Soil Compaction		✓				✓	✓	✓			✓			
Labour deployment camp siting	Construction of Labour sheds to accommodate labour Supply of water Supply of fuel/ Energy Waste handling & its disposal Sewage disposal		✓	✓	✓	✓	✓	✓			✓		✓	✓	
Excavation	Moving of Heavy Machinery Soil Extraction and Slacking Soil Loading and Transportation for Disposal Various Tools Like Crow Bar Foundations for heavy machinery installation Construction Power through onsite Diesel Generators			✓			✓	✓	✓	✓	✓				✓

Material handling & Storage	Transportation and Unloading of material from trucks Storage &Handling of steel sheets, metals, Fabricated structure, Cement, Concrete, Bricks, Steel etc. Conveyance of material within the project site			✓		✓	✓		✓	✓	✓		✓		
Plant Building construction	Transportation of material to construction site Preparation/ Mixing of construction material Supply of water Operation of construction machinery (like cranes, Concrete Mix Plant, Floor Developer, Forklift etc,) Handling and disposal of construction wastes , Diesel Generator Operation		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Erection of sheds, installation of Machinery Building Fittings & Furnishing	Erection of sheds -welding/ cutting onsite Installation .of heavy machinery, pumps Mechanical installation and Electrical installation Drilling and Fixing Painting/ White washing Disposal of Wastes (empty paint cans, containers, electrical waste, wooden and metal waste etc.)						✓	✓	✓		✓				
Demobilization of construction equipment	Dismantling of temporary support construction structures/ equipments Removal of construction machinery Transportation of Construction/ Dismantled waste Site cleaning/ washings			✓			✓	✓	✓	✓					

Site Commissioning	Trials functioning of Production &Warehousing units, Conveying and packing system, plumbic fixtures, Electrical gadgets, Fire fighting system, Effluent treatment plant, Lifts etc., Recruitments				✓	✓	✓	✓							
Laying Pumping Main	Excavation and alignment of pipelines along the berm of the road.	✓	✓				✓	✓	✓			✓			

Table 5. 2- Activity: Impact Identification Matrix for Operation Phase

Potential Activities	Air quality	Water quality	Surface Water resources	Ground water	Land and soil quality	Noise quality	Traffic volume	Ecological	Land use pattern	Socio economic	Air quality	Cultural impact	tourism	Onsite risks-hazards
Transportation of man and utilities materials	✓				✓	✓	✓							✓
Storage of Flammables like High Speed Diesel etc.	✓				✓									✓
Water demand for domestic purposes & utilities etc.,			✓							✓	✓			
Waste water disposal		✓	✓	✓	✓									
Wastes-packaging & other solid waste disposal					✓		✓			✓	✓			✓
Employment							✓			✓				✓

5. 3 IMPACTS IDENTIFIED

Based on activity – impact interaction matrix for construction and operation phase of the proposed project as shown in **Table 5.1 & 5.2** respectively, following impacts have been identified:

i. Construction phase of proposed project would have impacts on the followings:

- Topography, Land use pattern and Landscape
- Land / Soil Environment
- Surface / Ground Water Resources
- Water Quality
- Ambient Air Quality
- Ambient Noise Quality
- Traffic and Transport
- Ecology
- Socio-economic
- Safety of workers

ii. Operation phase of the project would have likely impacts on the following

- Air Quality
- Water Quality
- Ground water Resources & Surface water Resources
- Land and Soil Quality
- Noise Quality
- Traffic Volume
- Ecological
- Socio-economic
- Onsite Risks – Hazards
- Safety in O & M

5.3.1 Construction Phase

The proposed facility is being developed at Tirunelveli and Virudhunagar districts, Tamil Nadu. The development period for the initial phase is estimated as 30 months. The likely temporary and permanent changes on the study area due to the project are as follows:

- Temporary – Movement of construction vehicles like excavators, pay loaders, trucks, other vehicles for bringing construction material and construction work may bring minor temporary change in the land use in and around the study area by parking the vehicles on the open spaces and roads near the site and
- Permanent – Erection and installation of the various plant structures, pipelines and establishment of Head works and Booster Stations and utilities will bring permanent change to the local land use of the site.

5.3.2 Impact on Air Quality in Construction Phase

a. Fugitive dust emissions from excavation work, digging, stacking of soils, filling, handling of construction material, transportation of material, emission due to movement of tyres and plying of heavy construction machinery etc.,
b. Gaseous emissions from operation of diesel generators for power requirement during construction phase.
c. The dust levels in the Head Works and Booster Station, ridge sump areas are expected to be increased substantially during construction.
d. Similarly, the trenching work for pipe lines will generate considerable dust pollution along the pipe line routes.
e. Since heavy machineries used for the project will be less, hence impacts on ambient air quality due to vehicular emissions will be insignificant.

5.3.3 Impact on Air Quality in Operational Phase

- The key potential air quality impact during the operational phase of the treatment plant would be the emissions arising from the operation of D.G. Sets and handling of chemicals.
- No impact on Air quality is anticipated along the pumping main.

- The use of D.G. sets is anticipated only during power failure and hence is temporary and requires standard measures.
- Leakage of chlorine gas used for disinfection process in ULB sumps.

5.3.4 Impact on Noise Quality in Construction Phase

The major sources of noise due to construction activities are given below:

- Use of heavy machineries and vehicles during construction of Booster stations, Water Treatment Plant and along the pumping main.
- The construction works will however present a short term noise to the public.

It is envisaged that operation of these construction activity will generate noise levels between 75-80 dB (A). The combined effect of these noise sources may cross 90 dB (A) at the construction site, however noise dissipates as it spreads in area beyond the study area.

5.3.5 Impact on Noise Environment in Operational Phase

- Pumping will be done for 23 hours per day at the Head Works and Booster Stations. Few movements of vehicles and noise of motors, including other machineries, result in increase of ambient noise level and have adverse impact on the sensitive receptors.
- The booster station II is located at a distance of 83m distance from school.
- The major noise generating equipment during operational phase is air blowers, ventilation fans, water pumps and DG Sets in case of power failure.

5.3.6 Impact on Water Quality in Construction Phase

- However, during construction of the intake well, care will be taken to avoid dumping of construction debris, accidental spill of materials etc. into the River.
- Runoff from construction sites such as WTP, Booster Stations and Service Reservoirs during rainy season may pollute the surface water bodies by increasing turbidity level.
- Where the pipeline is laid in high slope the backfill may be scoured out during heavy rain and deposit silt into natural drainage channels and hence to the river.
- Spillage of oil and grease from the vehicles from vehicles washing, workshop etc

- Improper disposal of construction debris leading to off-site contamination of water resources

5.3.6.1 Environmental impact due to construction of Check Dam and Head Works.

- Increased water runoff and erosion from work sites could potentially result in siltation of downstream water courses and drainage systems.
- Excavations for foundations in the river channel at the check dam site could potentially result in siltation in the vicinity of check dam, on the upstream side.
- Construction of the check dam will potentially disrupt the natural flow of the River.

5.3.7 Impact on Water Environment in Operational Phase

Construction of Head works at Kondanagaram lead to change of stream course due to diversion channels to construct intake structures. The following impacts are,

- Improper Disposal of construction debris and excavated materials.
- Water quality in the source / water bodies.
- Wastage of water due to leakage or indiscriminate use.
- Filter backwash water.

5.3.7.1 Environmental impact due to operation of Check Dam and Head Works.

- During the operation phase of the project, the obvious change in aquatic diversity is going to take place in terms of fish movement upstream and downstream in the river.
- Due to unexpected floods may result an increase of flood plain on either side of the river bank on the upstream of the check dam.

- The requirement of water to be tapped from Tamirabarani river for existing water supply schemes is 730.708MLD or 9411 Mcft. The requirement of water for the proposed scheme water is 61.98 MLD or 798 Mcft per year after deducting the requirement of existing schemes and downside users from the total quantity of 16363Mcft per year resulting in net balance of 6154 Mcft per year under normal seasonal condition. Hence downstream users are not affected in getting water supply in all the seasonal condition .

5.3.7.2 Pipe corrosion in operation phase

Pipe corrosion is indicate the loss of pipe material due to action of water and water logged soil above the pipe surface by the result of corrosion the water authority and consumers. The following factors contribute the pipe correction.

1. Acidity, 2. Alkalinity, 3. Biological Action, 4. Chlorination.

5.3.8 Impact on Land in Construction Phase

- The proposed land is open and vacant. It is also observed that the proposed land is reclaimed land
- Major impact on land environment due to proposed project during construction phase would be from the waste generated from construction materials and substratum removed during excavation for lying down of pipe.
- During this phase, solid waste which will be generated will include various types of construction debris such as bricks, blocks, steel, formwork, finishing materials, etc. Most of this material will be used on site as backfill, remaining will be disposed to authorized waste disposal site.
- Spillage of oil and lubricants during the construction phase may degrade the soil quality.

5.3.9 Impacts Due to Waste Generation in Operational Phase

- Small amount of domestic waste from site, chemical waste from equipment maintenance are expected during operation phase.
- Improper onsite storage of domestic waste rise the adverse environmental impact such as odour nuisance, vermin and pests, water quality impacts, and adverse visual impacts.
- Spent oil from pump, motor, D.G set and other equipment.

5.3.10 Workforce Wastes in Construction Phase

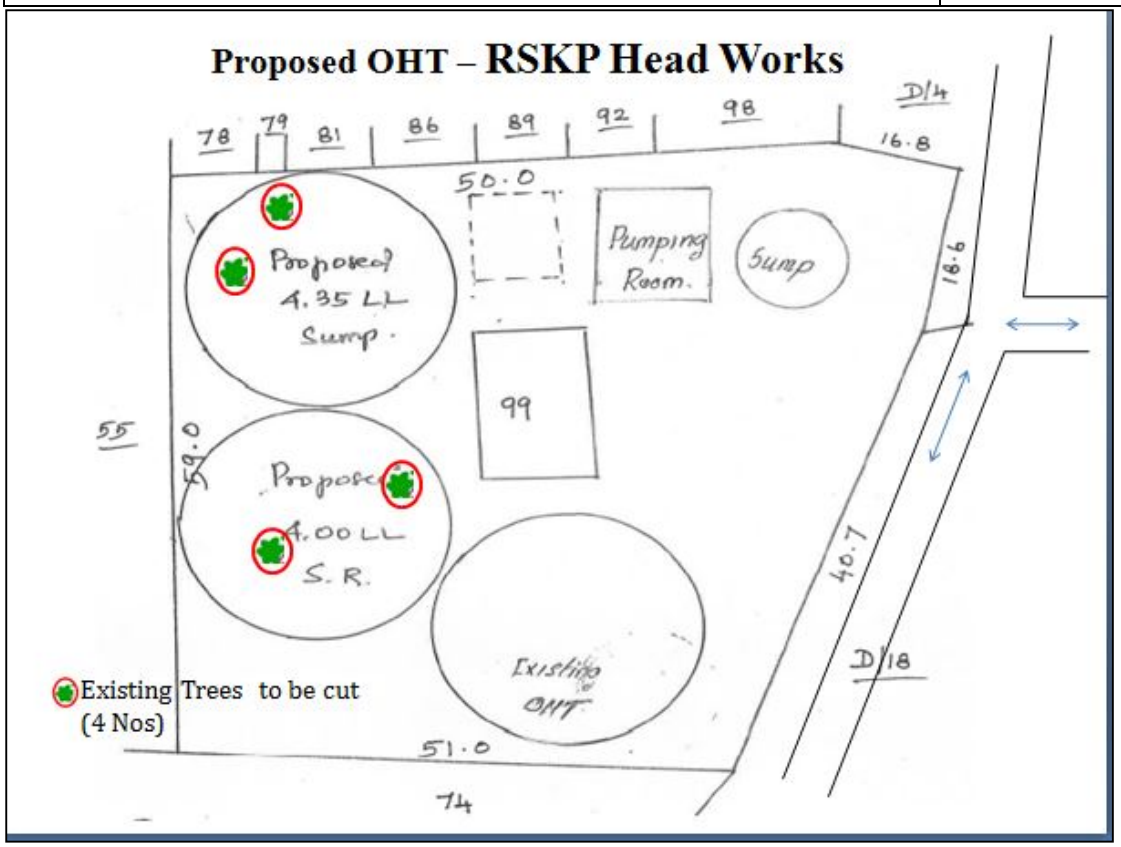
- Throughout construction, the workforce would generate general refuse, comprising food scraps, paper, empty containers etc.,
- The amount of general refuse which is likely to arise will be largely depend on the size of the workforce employed by the contractor.

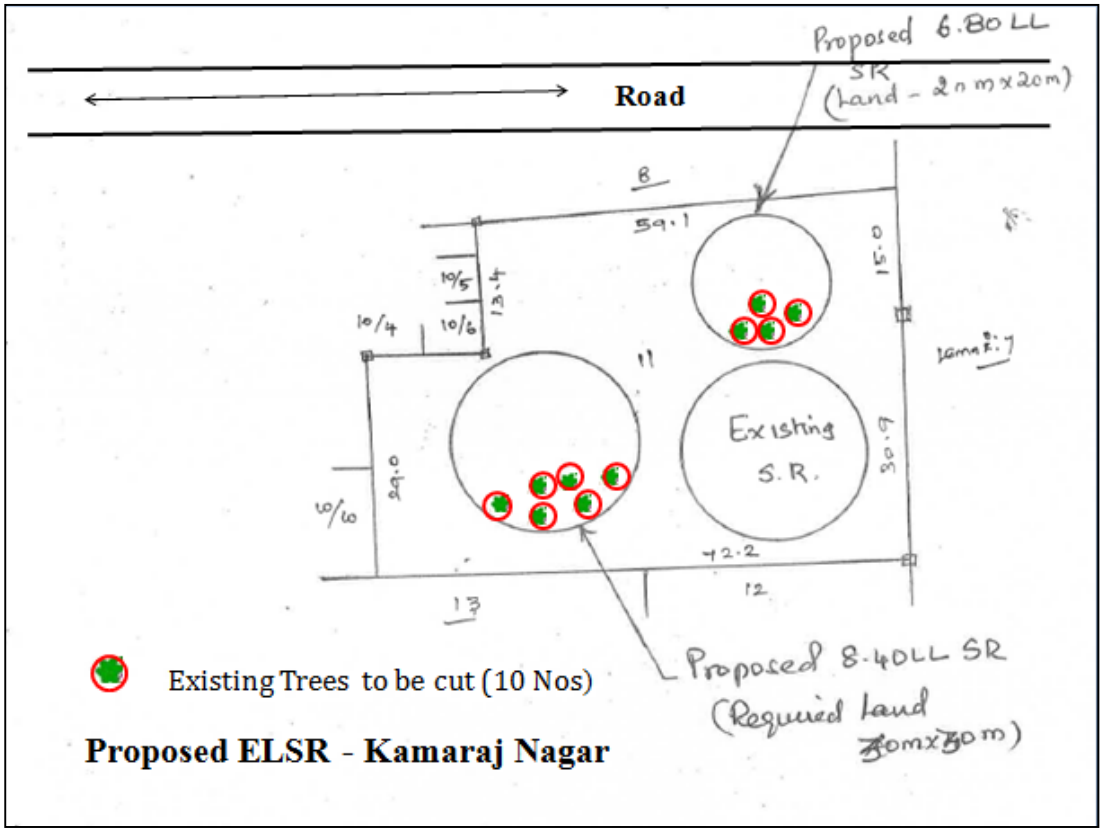
5.3.11 Ecology in Construction Phase

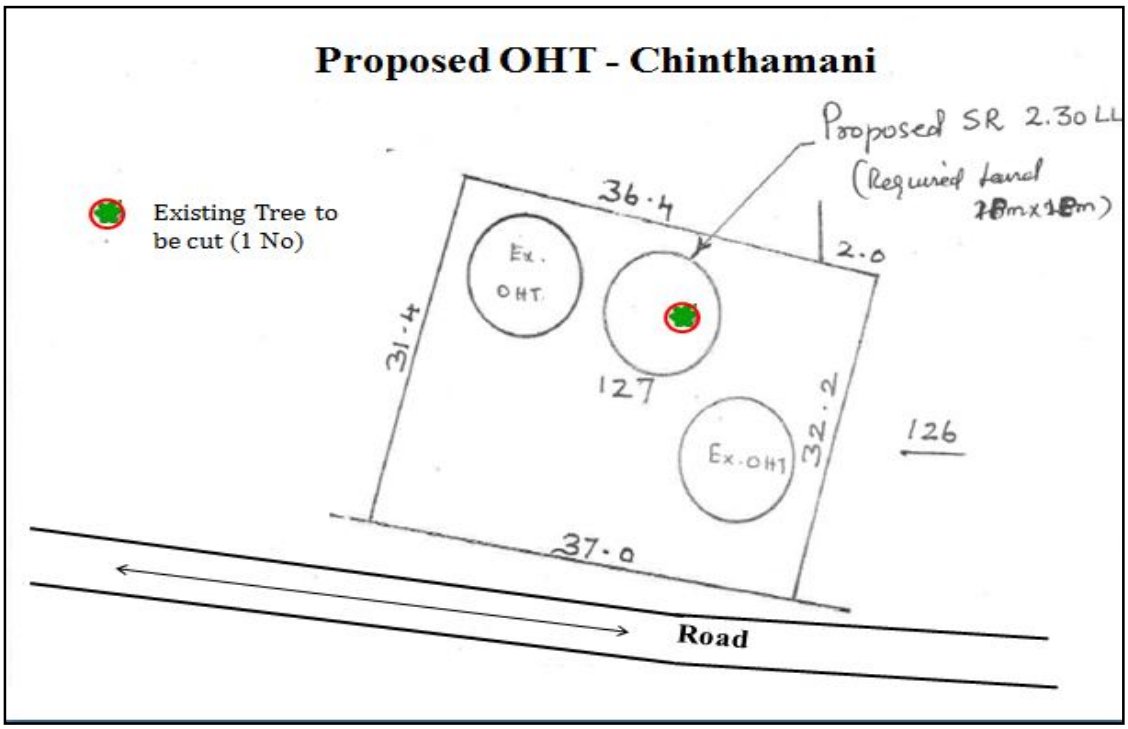
The proposed project involves cutting of 20 numbers of trees in the ULB sump and SR sites as there is no sufficient space available. The locations where trees to be cut down are given below:

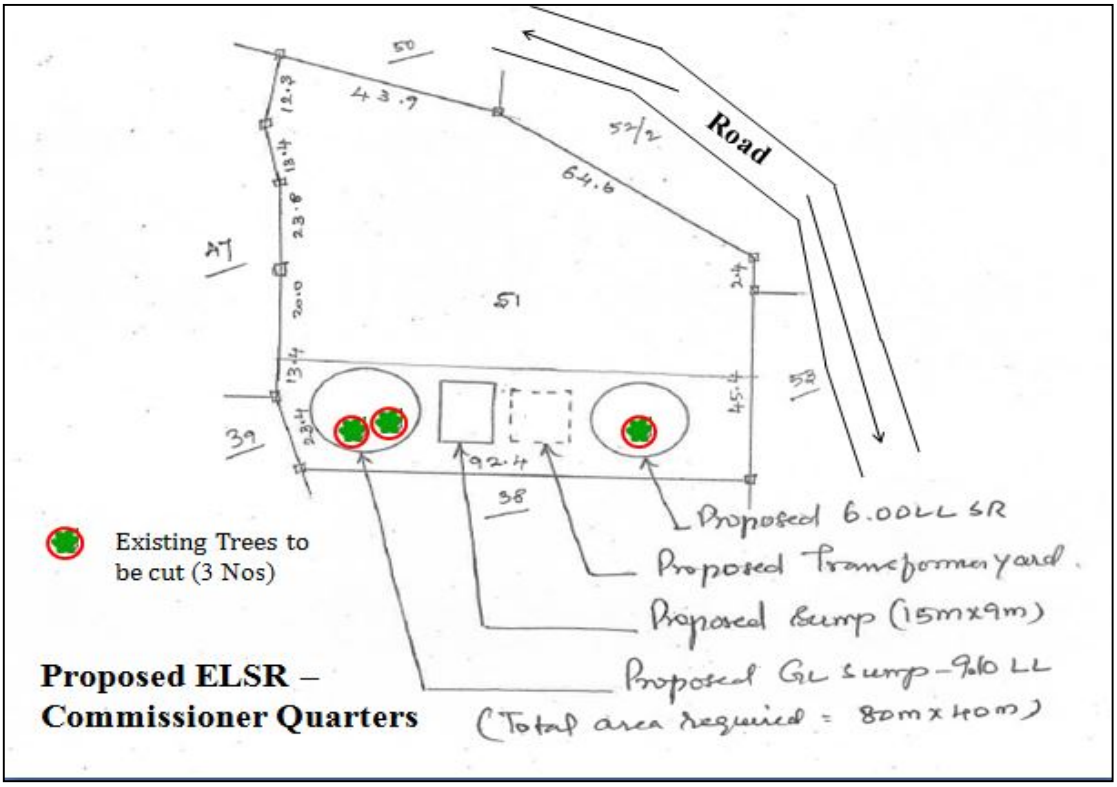
Table 5. 3- Trees to be cut at proposed ULB sumps and SR sites

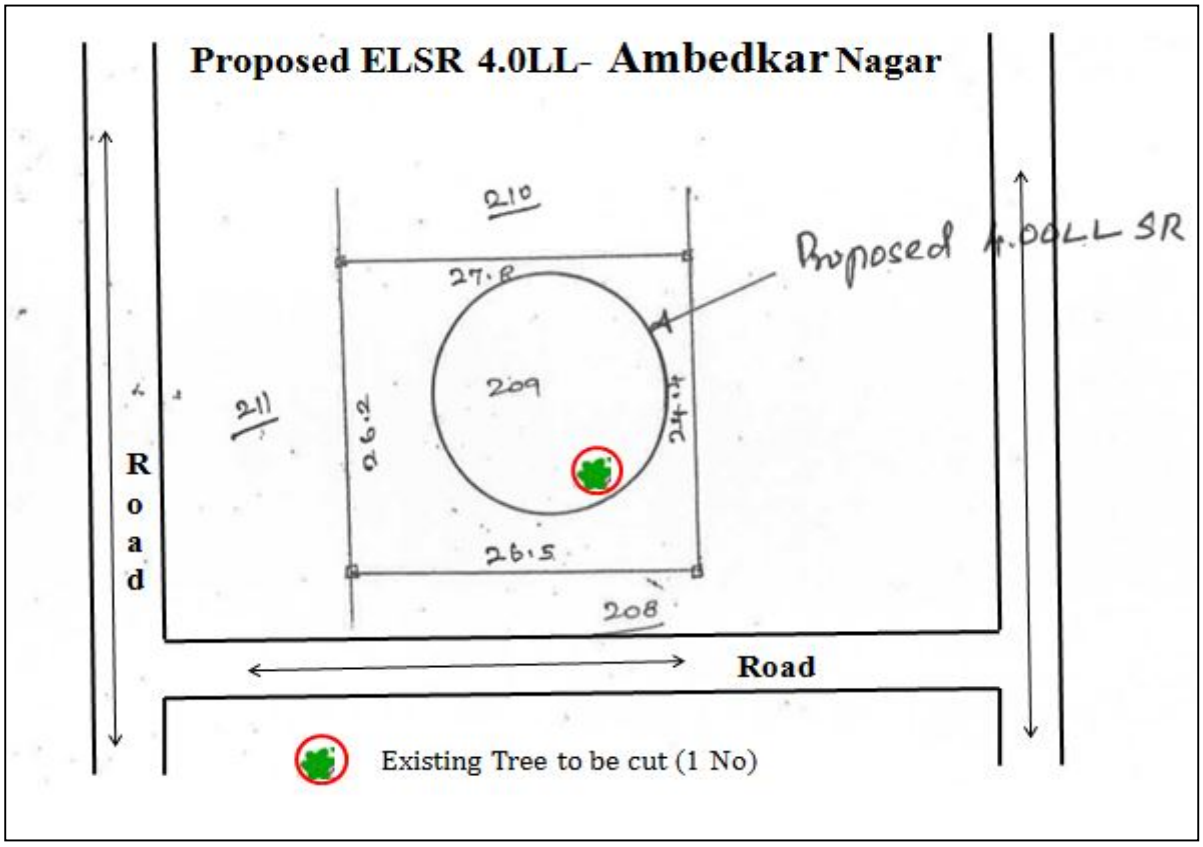
Location	Number of trees
Service Reservoir site at Chintamani (Puliyankudi Municipality)	2
Sump site at RSKP (Puliyankudi Municipality)	4
Service Reservoir site at Ambedkar Nagar (Rajapalayam Municipality)	1
Sump site at Commissioner's Quarters (Rajapalayam Municipality)	3
Service Reservoir site at Kamaraj Nagar (Rajapalayam Municipality)	10
Total	20




Proposed 6.80 LL SR (Land - 20m x 20m)
Road
8
59.1
15.0
10/5
13.4
10/4
10/6
11
Existing S.R.
30.9
29.0
10/10
42.2
12
13
Existing Trees to be cut (10 Nos)
Proposed 8.40LL SR (Required land 30m x 30m)
Proposed ELSR - Kamaraj Nagar


Proposed OHT - Chinthamani
Proposed SR 2.30 LL (Required land 18m x 18m)
Existing Tree to be cut (1 No)
36.4
2.0
Ex. OHT
31.4
127
32.2
126
Ex. OHT
37.0
Road


Road
50
43.7
64.6
52/2
51
39
38
92.4
Existing Trees to be cut (3 Nos)
Proposed 6.00LL SR
Proposed Transformer yard
Proposed Sump (15mx9m)
Proposed GL sump-960 LL
(Total area required = 80m x 40m)
Proposed ELSR – Commissioner Quarters


Proposed ELSR 4.0LL- Ambedkar Nagar
210
27.8
209
211
208
26.5
Road
Road
Existing Tree to be cut (1 No)

5.3.12 Impact on Heritage or Cultural Aspects in Operational Phase

There are no historical monuments and structures in the proposed area and insignificant impact is envisaged from the proposed project on heritage or cultural aspects in the study area.

5.3.13 Social impact in Construction Phase

The construction phase will require construction workers, which will largely be drawn from the local population and nearby villages. Thus, it will provide temporary employment to number of families and that will be a positive impact due to the proposed project. The proposed project will also employ skilled people and that may be sought from outside. These people will largely be based in nearby small towns. The project will provide up to more than 100 Employment opportunities in Construction Phase.

- Constructional phase of the project will lead to air pollution, noise pollution in their respective areas. Dust problem will arise which may affect some people
- Communication and power supply facilities are likely to get affected in the area during construction
- Improper planning of construction activities may lead to traffic jam, diversion of traffic and related problems cause trouble to public movement.
- Potential road safety risks from construction vehicles and trucks delivering material to the construction sites. Maintain speed limit construction and laying area.

5.3.14 Social Impacts in Operational Phase

The construction of the **CWSS** is a positive and necessary intervention. However there are both positive and negative impacts of this proposed new water treatment plant. With the population increase, the implementation of this project is necessary to meet with the population needs. Almost 435150 inhabitants will benefit from the newly installed water network. Other major enhancements include timely supply, better equitable water distribution, and extensive service area

- For assessing the social impacts as per ESMF, a study was carried out and it was observed that the project activities do not involve any private land acquisition, Resettlement & Rehabilitation etc.
- The improved water supply leads to more sullage and drainage problem unless Controlled properly

- Improvements in the drinking water quality and increase in the water supply represent the most important positive impacts of the project.
- It leads to improved standard of living and find time for recreation and other activities.
- Continuous running of motors at head works, sumps likely to cause noise pollution
- The quality of potable water provided improves the health of the residents and thereby longevity of the people will also be increased
- Reduced distances to water points which will lead to gain in productive time for women and girls; and
- Better and properly sited sanitation facilities will reduce the risk of contamination of surface and groundwater resources.
- The project will provide up to more than 20 Employment opportunities in operation phase.
- It expected that all works related to the project will provide a positive increase to the local and national economy in general This will fully contribute to the increase of human socio-economy benefits within and around the project area.

5.3.15 Focused areas of Alignments and Booster Stations

During the construction phase, when the pipe line are laid along the berm of the road issues are anticipated. Their strip maps are as follow.

Figure 5.1	Alignment adjacent to Tirupaniparisalkulam pond	Pumping main of 900mm diameter will be laid on the right of way available at the berm on the right side of the road.
Figure 5.2	Booster station II at Panavadalichatram	The government school located in 83m distance from booster station II.
Figure 5.3	Alignment through Sankarankovil town	Utilities like street light will be relocated.
Figure 5.4	Booster station III at Sankarankovil	The solid waste dumped shall be removed by the municipality and made free for the construction of proposed sump. Total area of the dump yard is 2 acres & out of which 1.5acres will be used.
Figure 5.5	Alignment near Thiruthangal road	Utilities like street light will be relocated.

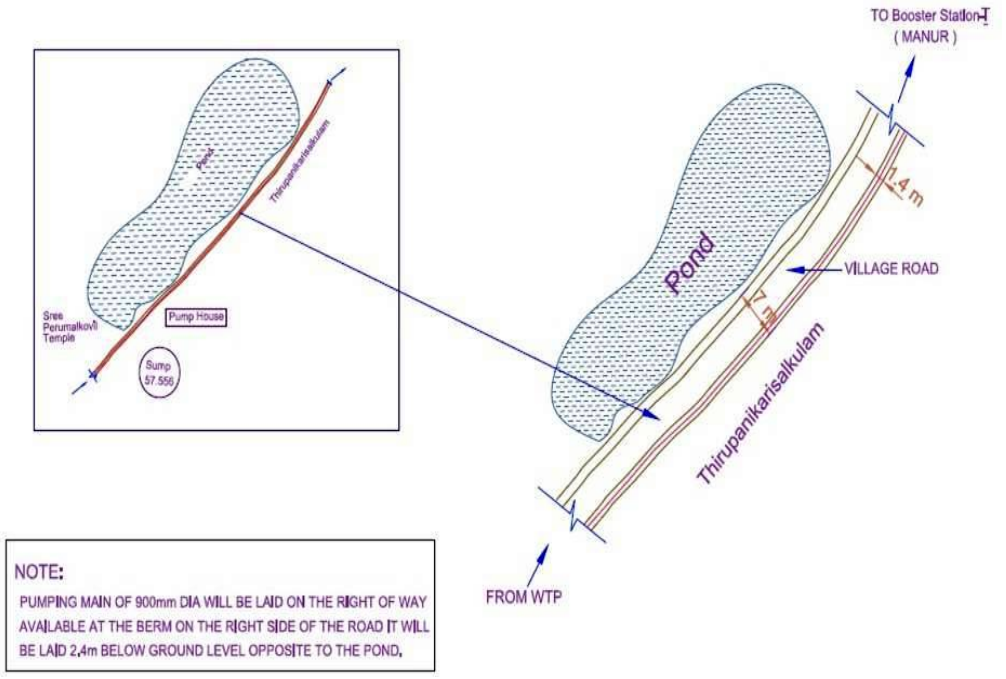


Figure 5. 1– Alignment adjacent to Tirupaniparisalkulam pond

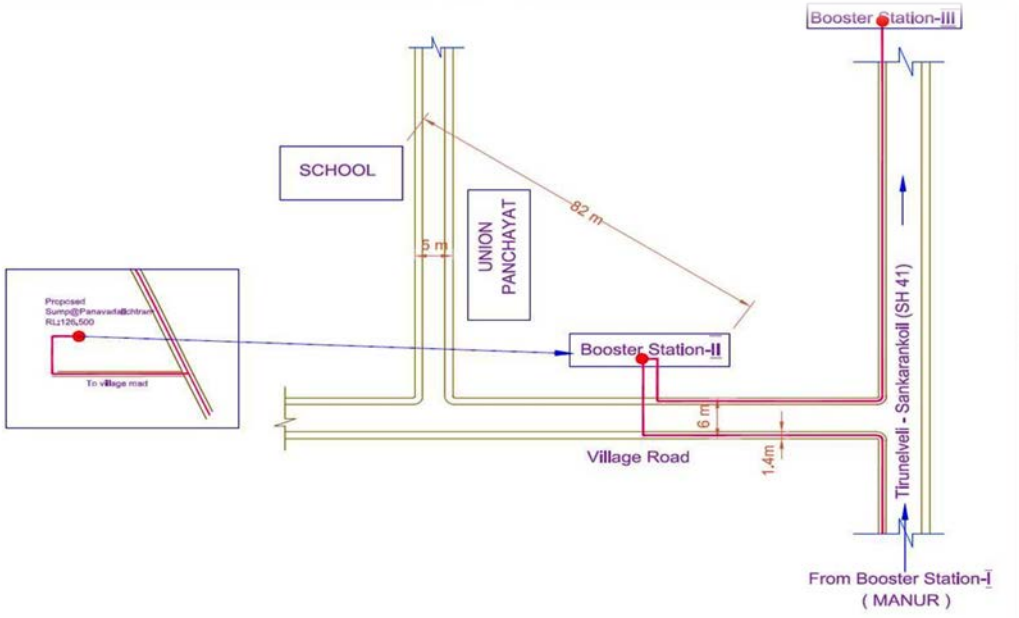


Figure 5. 2–Booster station II at Panavadalichatram

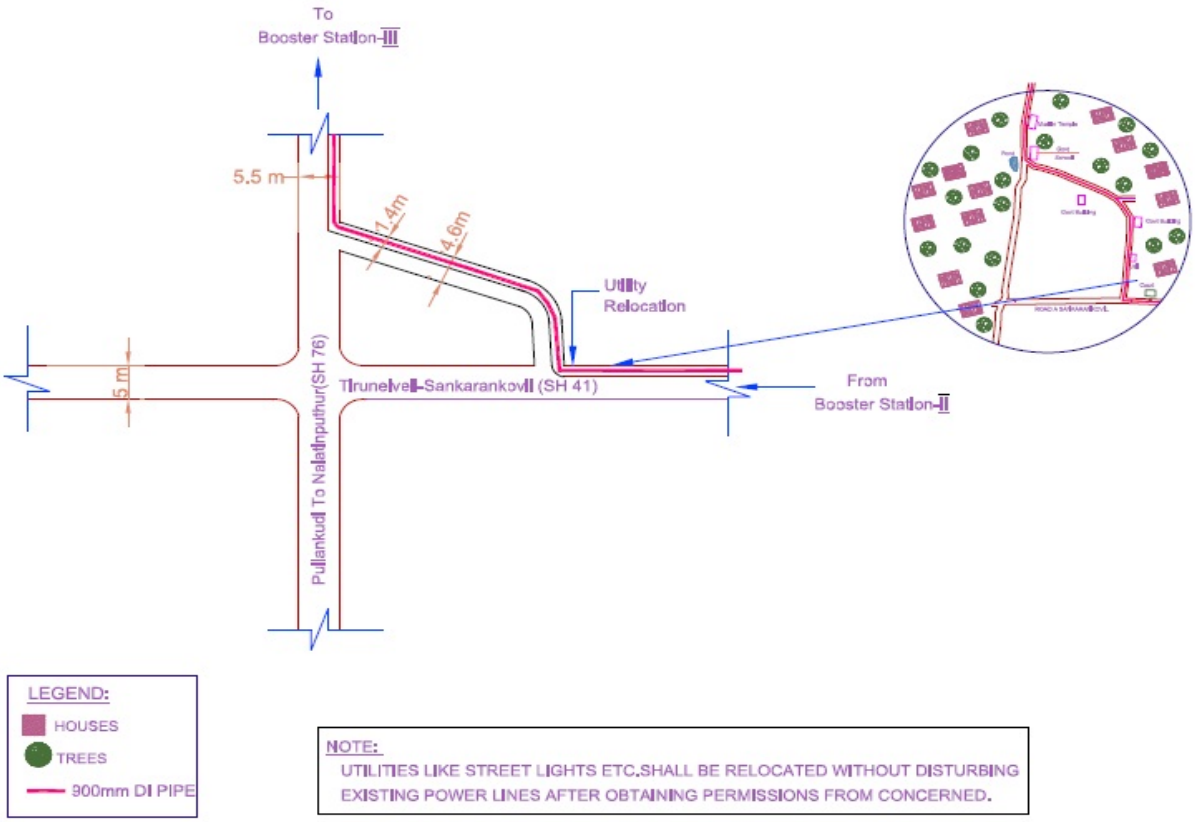


Figure 5. 3–Alignment through Sankarankovil town

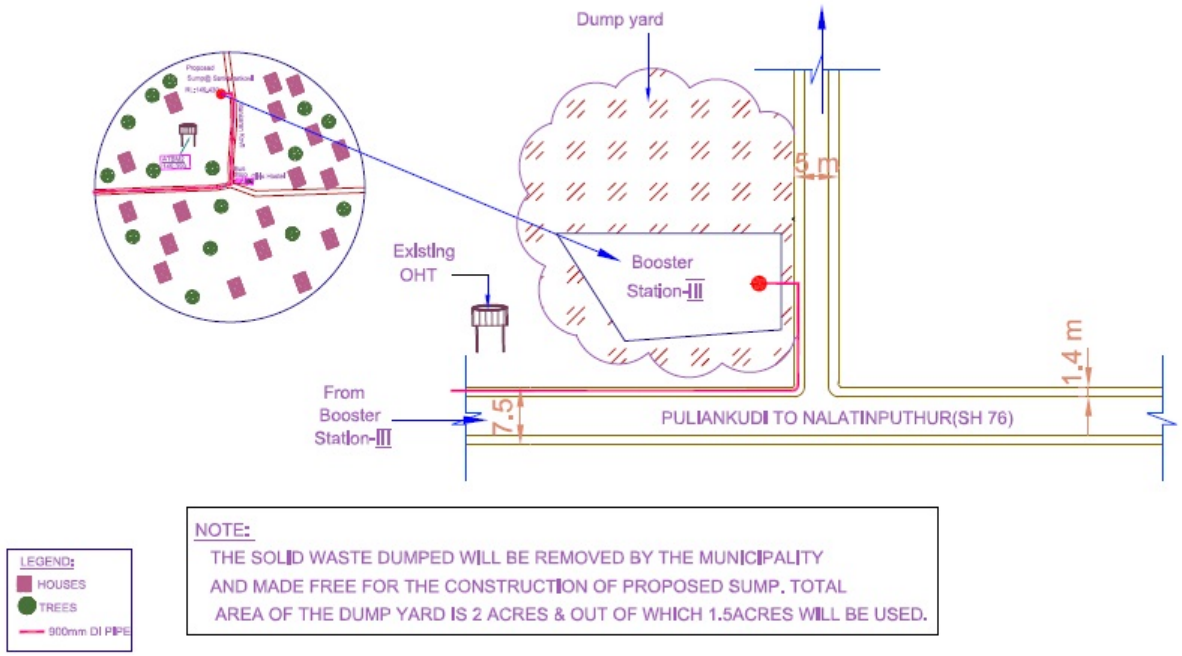


Figure 5. 4–Booster station III at Sankarankovil

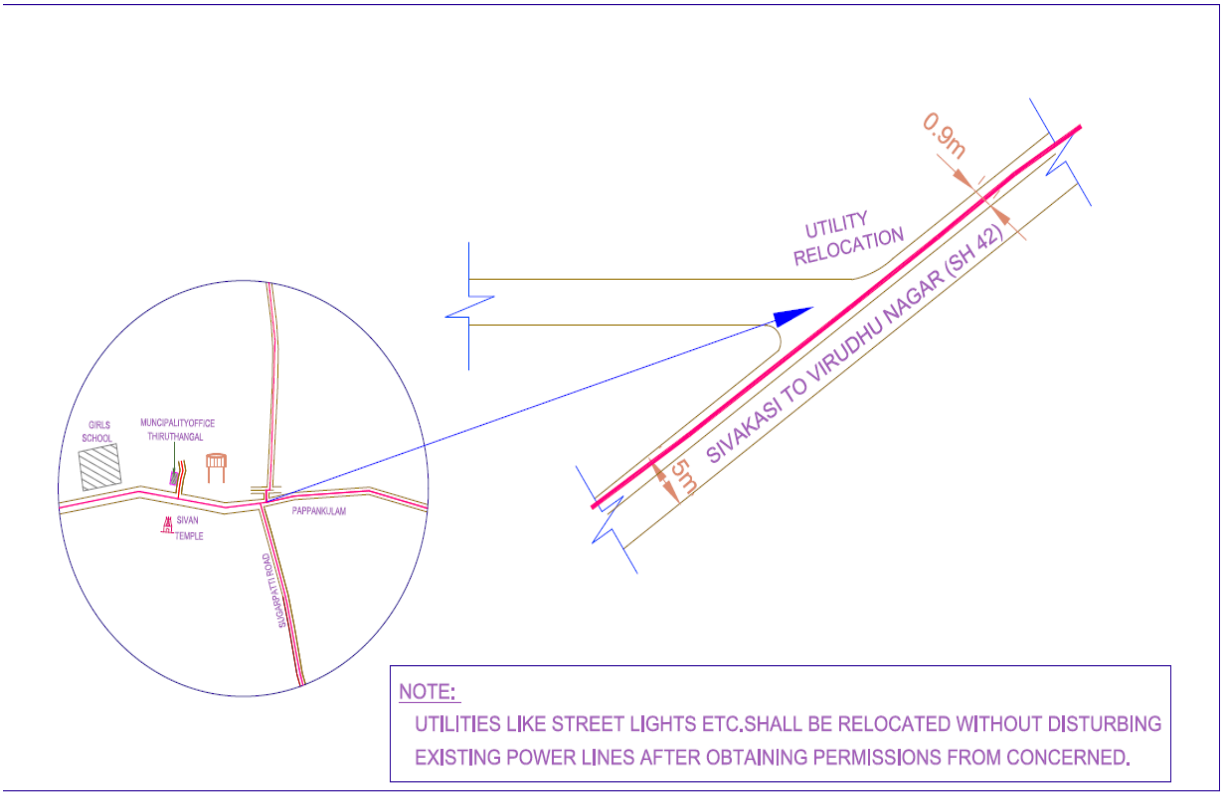


Figure 5. 5–Alignment near Thiruthangal road

5.4 MITIGATION MEASURES DURING CONSTRUCTION AND OPERATION

Mitigation Measures

The impacts during the construction phase on the environment would be basically of transient nature and expected to reduce gradually on completion of the construction activities. In order to mitigate them, the following measures are proposed.

5.4.1 Air Environment in construction phase

- Provision is made available for water sprays to be used when dusts are being generated. All materials stored or stockpiled on treatment plant site and in booster station site will be adequately covered, and vehicles leaving the site should pass through wheel washes where practicable.
- The emissions from diesel generators need to be controlled to minimize impacts of air emissions by optimized operations, orientation at the site and providing adequate stack height for wider dispersion of gaseous emissions.

- The diesel generators (DG Sets) to be installed will be in conformance with recent requirement of acoustic enclosure to achieve 75 dB (A) level at 1m from its enclosure.
- Minimize these minor air quality impacts on the ambient air quality, measures such as periodic watering during construction and other dust suppression measures will be implemented.
- Pipes will be brought to the site in well maintained trucks.

5.4.2 Air Environment in operation phase

- The gaseous pollutants will be generated mainly from Diesel Fuel combustion from diesel generators, material handling and also from operation of transportation vehicles. D.G. Sets are proposed in headwork, WTP site, booster stations and ULBs sumps.
- Diesel generators will be operated only for emergency power backup. The emission source diesel generators will have adequate stack height will conformance to the set norms of CPCB and regular maintenance of diesel engines has to be ensured. Seasonal monitoring of air quality through an approved monitoring agency will be carried out at these locations. The parameter to be monitored, frequency and duration of monitoring plan are given in Table 6.3.
- Dust emission from the transportation vehicles will mainly contribute to NOx and Carbon Monoxide. Management will ensure that all the private and commercial vehicles entering into the site are in proper condition and there is no visual sign of major emissions from the vehicles. Also it is to be ensured that all the vehicles are holding valid Pollution under Control Certificates.
- Separate storage rooms for full, partial, or empty chlorine cylinders.

Chlorine Leak Detection

Automatic chlorine leak detection and related alarm equipment to be installed at chlorine storage room in ULBs sumps. It is connected to a remote audible and visual alarm system and checked on a regular basis to verify proper operation. The detectors will have two adjustable alarm levels sensitive to chlorine concentrations above 1 mg/m^3. Low level

alarm will give indication if the level goes beyond 2 mg/m^3. The **Table 5.4** presented the toxic effects of chlorine.

Table 5. 4- Toxic Effects of chlorine

Toxic Effects of chlorine	Concentration of air in ppm
Immediately fatal	1000
Dangerous to life it exposure lasts for approximately 30 min	50
Severe toxic effects if exposure lasts for approximately 1 min	10

5.4.3 Noise Environment in construction phase

- Avoiding construction is during night time so that the noise levels are reduced to the permissible limits.
- Considering the onsite noise levels, it is recommended to provide Personal Protective Equipment (PPE) such as ear muffs, etc. to the construction workers.

5.4.4 Noise Environment in operation phase

In operation phase noise source is generated from the treatment plant and booster stations.The mitigation measures proposed to abate noise pollution during operation phase are

i) Noise modeling for Booster Station
ii) Noise Barriers
   - Mass loaded Vinyl (MLV)
   - Soundproofing Curtains or Draperies
   - Foams
iii) Plant Species for Noise Pollution Control

(i) Noise modelling for Booster Station

The noise simulation modeling is used for the Booster station I, II, &III. The sound field determined by the emission of the plant items is estimated using the **Sound PLAN** calculation model revision 7.4, developed by Braun stein& Berndt GmbH in Germany.

Based on the modelling analysis, the minimum distance from the booster station to booster station boundary wall will be 25 m, such that it meets the maximum reduction

of sound to comply with the silence zone limit of 40 dBA. Based on the modelling results, it is safe to estimate that during normal operations of the booster station, would not impact the residential neighbourhood of the area. It is always advisable that a buffer zone or setback distance of 20 m is allowed.

Moreover, the maximum calculated Sound Pressure Level of day time limit of 55 dBA is within 10m from the noise source location and at 40 m the expected noise level is 40 dBA. Based on the site layout the minimum distance to the boundary wall is 50 m from the Booster Station. Therefore, the expected noise level from the Booster Station will be below the 40 dBA during the daytime.

At present a school is located at 83m from the booster station at Panavadaichatram. Based on the modelling, the expected noise level at this distance is 35 dB(A) and at the booster station boundary (distance is 40m), the Noise level is expected to be 40 dB(A) which is well within standards. At other booster station sites and ULB sumps, there are either no residences in the immediate neighbourhood or minimum buffer is available, and expected noise level is also lesser. At all these sites, plantation is being proposed as part of the project, which would contribute to reducing the noise levels. Hence, at present there is no need for providing mitigation measures. However, during operation noise monitoring would be carried out periodically and if need arises in future mitigation measures like barriers would be examined and be provided in order to reduce the noise level.

The detailed noise modelling is enclosed in **Annexure VIII.**

ii) Noise Barriers

Different types of Noise barriers used for reduce the noise level, the barriers details are given below.

- **Mass loaded Vinyl (MLV)**

This material has become one of the top rated and largely purchased items for industrial sound proofing worldwide. **MLV,** which was developed as a non-toxic replacement for lead sheeting, can be used with industrial floors, ceilings and walls for efficient and cost-effective sound proofing. Made of high-grade vinyl material that is suffused with barium salts or silica, (Silica is best), MLV can protect you from annoying

noise. In India price range starts from Rs 120 /sq.ft 2mm thick and 6mm thick is Rs 475/sq.ft.

- **Soundproofing Curtains or Draperies**

This is the easiest and most cost-effective way for achieving sound deadening in industrial setups. They can be hung easily on the wall or windows of industrial office rooms, so that any disturbing noise from the manufacturing and processing department will not affect your peace of mind and concentration. Available in different thickness, they can be used to block 90% of the noise coming in or out of a room. Price: Rs 350/sq.ft

- **Foams**

Closed cell foam is used as a sound blocker as we as absorber while open cell foam is used as an absorber. Available in various styles and shapes, foam can be glued, pinned or stapled to the wall and/or ceiling of work rooms. They are cost effective and at the same time highly efficient for absorbing sound waves. Price: Rs 55/sq.ft

Table 5. 5- Comparison of Noise Barriers

S.NO	Mass loaded Vinyl	Sound proofing Curtains or Draperies	Foams
1	It is lightweight panels, walls, or enclosures and effectively reduces transmission of both airborne and structure borne noise.	Curtains made from these fibers are water resistant and windproof.	Acoustic foam is a lightweight material made from polyurethane foam either polyether or polyester.
2	Reduces noise transmission through ceilings, walls, floors, machinery and equipment, enclosures,	It is mostly used in window. In order to provide a barrier against noise, soundproof curtains will be at least 2 to 3 inches (5.08 to 7.62 mm) thick.	Acoustic Foam is perfect for: Ceiling tiles, utility rooms, equipment enclosures, machine rooms, Medical facilities, clean rooms, computer rooms, offices
3	db reduction by density 1.5 kg/m=26db 2.3 kg/m=29db 3.0 kg/m=31db	db reduction by density 0.75 kg/m=20db 1.0 kg/m=23db 1.5 kg/m=26db	db reduction by density 1.5 kg/m=25db 2.3 kg/m=27db 3.0 kg/m=29db

4	Temperature Range Up to 85^{0}C	Temperature Range Up to 70^{0}C	Temperature Range Up to 75^{0}Cs
5	Cost - Rs 120 /sq.ft - 2mm thick and 6mm thick is Rs 475/sq.ft.	Cost -Rs 350/sq.ft	Price: Rs 55/sq.ft

iii) Plant Species for Noise Pollution Control

Trees having thick and fleshy leaves with petioles flexible and capacity to withstand vibration are suitable. Heavier branches and trunk of the trees also deflect or refract the sound waves. The density, height and width are critical factors in designing an adequate noise screen plantation. Combination of trees and shrubs together with suitable landforms and design appears to be the best system for combating noise pollution.

The following species are directed to absorb noise pollution:

Sl.No	Species Name	Tamil Name
1	*Alstonia Scholaris*	Ezilai Pillai
2	*Azadirachta Indica,*	Veppa maram
3	*Melia Azedarach*	Kattu Vembhu
4	*Casuarina equisitifolia*	Savukku Maram
5	*Terminalia Arjuna*	Marudha Maram
6	*Polyalthia Longifolia*	Ashoka maram
7	*Butea monosperma*	Parasu maram

iv) Others

Besides these four common and economical noise control materials; barrier, RC channel/sound clips, foam mats, green glue, insulation of mountings, isolation pads and spring hangers, vibration pads, panels, soundproofing doors and windows etc., are also used to block the unwanted noise and sound.

5.4.5 Water Environment in construction phase

- Restoration of river bed to its natural shape will be done by removing debris that may obstruct the flow.
- Proper mitigation measures like provision of septic tank and soak pit for treatment and disposal for the waste water generated onsite during the construction phase. This will minimize any potential impact owing to the escape/discharge of untreated waste water into the nearby land or drain ensuring minimum impact.

5.4.5.1 Mitigation Measures for construction of check dam and head work

- Proper approach to proposed Head works from the bank is to be ensured so that conveying main can be safely laid over proposed pipe carrying bridge without affecting flow regime.
- Coffer dams provided for construction of head work and check dam without any disturbance of river water flow. Upon completion, the coffer dam and other construction debris will be removed ensuring restoration of river bed.
- Location of the Head work is 100m away from the check dam, so as to minimal siltation.
- During heavy rain fall and floods when water flows with high velocity, the sluice gates in check dam are kept open.

5.4.6 Water Environment in operation phase

- A suitable site identified for safe disposal of oil and grease from Water Treatment Plant without contaminating the source, in relatively low lying areas, away from the water bodies etc., as approved by the Engineer & as per specific procedures.
- In operation phase toilet facilities will be provided for workers to maintain proper standards of hygiene. These facilities include provision of septic tank followed by soak pit and maintained to ensure minimum impact on nearby water bodies and environment.

5.4.6.1 Mitigation Measures for operation of check dam and head work

- Check dam construction and maintenance would be carried out by PWD upon cost deposit by TWADB. When the silt deposition becomes appreciable the sluice gate will

be opened and the deposited silt is loosened with an agitator mounting on a boat. The muddy water flow towards the downstream through the scouring sluices.

- During operation phase people living in the vicinity of check dam may be well in advance informed during flood by District Administration so as to avoid loss to human beings and cattle.
- No any pollution created upstream side of Tamirabarani River.
- The requirement of water to be tapped from Tamirabarani river for existing water supply schemes is 730.708MLD or 9411 Mcft. The requirement of water for the proposed scheme water is 61.98 MLD or 798 Mcft per year after deducting the requirement of existing schemes and downside users from the total quantity of 16363Mcft per year resulting in net balance of 6154 Mcft per year under normal seasonal condition. Hence it is evident that water supply for the proposed scheme is sustainable in all seasonal condition .

5.4.7 Water Resource Management

a) ***Control of Water leakage/wastage***

- The quantity of water outflow will be monitored by Electro-magnetic flow meters (EMF) at the outlet of WTPs, booster stations, and ULB sumps.
- Control valves would be provided in the inlet of all booster stations, ULB sumps and service reservoirs to control the flow. It can be used to stop the flow until the leakage is rectified. Water meters at pumping stations are used to measure and monitor the flow. In this project, monitoring and controlling the flow in the system will be done with flow control valve with the help of SCADA system.
- Surge protection arrangements have been provided in the clear water main at three locations in order to avoid line bursts to prevent wastage.
- Air valve is provided at an interval of 500m in all transmission main to prevent leakage.
- On-line monitoring through SCADA is proposed which would prevent overflow and wastage water.

b) SCADA System

It is proposed to implement system with the following parameters to be monitored at the Head works, Booster stations, ULBs sumps, Service Reservoirs and at the Major tapping points or Branch point and gathering the real time data from remote locations, so as to monitor the entire components at a reduced maintenance cost. Centralized data storage and monitoring at the Master Control Room of the project is proposed at Sankarankoil Booster station.

1. Level in the collection well.
2. Pressure at the discharge line.
3. Flow at the discharge line of pump houses.
4. Energy monitoring of each pump outlet.
5. Control valves actuator in the tender specified locations.
6. Flow at the inlet of Master Service Reservoirs/ Sumps.
7. Level at each Sumps and at Service Reservoirs.
8. Control valves at the outlet line of the OHTs/ Reservoirs.
9. Data recording at the Pump houses, Booster station, ULBs sumps, Major tapping points and at Reservoir.
10. Automation for controlling the wash water from wash water tank and waste water from backwash to recycling sump at Water Treatment Plant.
11. Data transfer from RTU/PLC to SCADA monitoring Master Control Room (MCR). Centralized data storage and monitoring at the Master Control Room of the project.

c) Back wash recycle

The backwash water is collected in the recycle sump and the solids allowed settling during one hour detention period. Backwash water will be re-circulated with raw water to the stilling chamber for further Treatment process. The backwash will be reused through recycle sump for treatment. The backwash wastewater may also be used for gardening within the WTP premises.

5.4.8 Land environment in construction phase

- Mitigation measures should include provision of a collection area where waste can be stored and loaded prior to removal from the area.

- During construction of pumping mains, the disposal of construction debris to be used for levelling in low lying areas as directed by the respective Engineer in charge.
- The top soil to be protected and compacted after completion of work, where the pipelines run, including open lands and agricultural lands.
- Delivery of material on site to be done over a durable, impervious and level surface, so that first batch of material does not mix with the site surface. Availability of covered storage to assured.
- Compound wall of height 2.0 m all around for safety purpose.
- In the event of any damaged pipes found in the distribution system will be replaced with high density polyethylene pipes. The damaged pipes will be disposed to TSDF approved by TNPCB and in consultation with engineer concerned.

5.4.9 LAND ENVIRONMENT IN OPERATION

a) Sludge Handling

Water treatment sludge includes sludge from Aeration of particulate matter in raw water flocculated and precipitated material resulting from chemical coagulation at Clarifiers, or residuals of excess chemical dosage, plankton etc.

- Usage of chemicals (lime and alum) and generation of maximum amount of sludge generation in monsoon season is 1474 kg/day. During normal season only,1/3 (492 kg/day) of sludge will be generated. Sludge from Water treatment will be dried in sludge drying beds. The dry sludge will be stored in sludge pit and utilized for filing in low laying area. Drained Water collected from sludge drying bed will be re-circulated and used for gardening.
- Sludge containing Alum from the clarification unit of Water Treatment Plant (WTP) would be stored in inside the treatment plant site. It may lead to soil contamination, if not disposed properly.

5.4.10 Handling of wastes in construction

- Special handling and storage arrangements for materials classified as chemical wastes will be done before removal for appropriate treatment at the chemical waste treatment facility.

- Adequate and safe sludge disposal facilities provided.
- Materials wasted on site will be reused at the same place. For example, use of excavated earth in landscaping, or use of waste pieces of floor tiles in floor of porch or outdoor spaces, or use of remaining pieces of glass from window panes into ventilators, skylights and boundary wall, or reuse of ply and other timber pieces into furniture etc.,
- Hazardous materials will be stored in impervious to prevent leaks and spills.
- Contractor will 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 MoEFCC and state PCB guidelines.
- The contractor will provide garbage bins in the camps and ensure that these are regularly emptied and disposed off in a hygienic manner as per the Comprehensive Solid Waste Management Plan approved by the Engineer. Unless otherwise arranged by local sanitary authority, arrangements for disposal of night soils (human excreta)suitably approved by the local medical health or municipal authorities or as directed by Engineer will have to be provided by the contractor.

5.4.11 Handling of wastes in Operation

i) The dry sludge will be stored in dry sludge pit and utilized for filing in low laying area.

ii) The backwash water is collected in the recycle sump and the solids allowed settling during one hour detention period and will be recirculated into the treatment unit. Besides, this will also be reused for green belt in WTP premises

iii) Quantity of sewage generation from toilet during operation phase will be treated by providing septic tank followed by soak pits.

iv) Spent oil from D.G Will is handed over to approved recyclers by TNPCB.

5.5 DESIGN CONSIDERATION OF SAFETY IN CONSTRUCTION

In the design of treatment plant, it is of paramount importance to consider the safety of the operating personnel. The consideration of following aspects is necessary to avoid possible hazards like physical injuries and infection etc.

1. For all the units suitable RCC Staircase will be provided for access to the floors in different levels.
2. Independent and continuous acess to units with walkway of 1m width.
3. Guide Guards will be present while moving parts of the equipments.
4. Good natural and artificial illumination will be provided.
5. Reliable rails and hoists will be used.
6. Sufficient head room will be provided in all working and walking space.
7. Access Roads of adequate width all around the units will be provided for maintenance.

5.5.1 SAFETY ASPECTS OF O & M

1. Adequate ventilation of pump house provided.
2. All deep structures protected against uplift pressure considered depending on ground water condition.
3. Walk ways adequately designed
4. Minimum 2 pumps provided to facilitate repair in case of maintenance.
5. Adequate by passes considered in order to (1) take care of overflows (2) isolate any unit for repairs.
6. Arrangement for visible overflows, expansion pipes, rather than sophisticated detection instruments and alarms will be included.
7. Position electrical equipments, switches, cables conveniently for easy access and for avoiding dipping in water in case of flooding will be considered.
8. Pneumatic or hydraulic (not electric) transmission system for automatic valves will be provided protection against correction of equipment will be made.
9. Resistant materials/metals will be considered.

a) Facility for Workers

Basic facilities such as toilet, drinking water, electricity health, eye shower, first aid facility and safety gadgets, personal protective equipments (**Safety Glasses, Splash-proof Goggles, Gloves, Hearing Protection, Safety Shoes or Boots and**

Respirators) for chemicals and sludge handling will be provided at the Water Treatment Plant and Booster stations.

b) Other item of safety equipment should include

(a) First aid kits (b) stretchers (c) fire extinguishers, (d) Gas and fire alarms, (e) portable combustible gas indicators, (f) hose and gas makes, (g) emergency portable lights, (h) an oxygen efficiency indicator.

5.5.2 Safety for Chlorine storage

- The chlorine cylinder and feeders to be housed in an isolated room, easily accessible, close to point of application and convenient for truck loading and safe container handling.
- The floor of the chlorine room is above the surrounding ground and drainage.
- Chlorine room is provided with ventilation that allows an approximate air change in 10 minutes.
- Cylinder containing chlorine are handled gently. They will not be bumped dropped or rolled on the ground and no object should be allowed to strike them with force.
- The protective hood over the value always kept in place except when the cylinders are in use.
- Cylinders will not be stored in open or damp places and Empty cylinder will be stored away from full cylinders.
- Chlorine cylinder loading and unloading will be done with using special clamps, lifting tackle.
- Safety measures like Chlorine leak alarm, eye showers etc., will be provided.
- Respirators will be used for during chlorine container renewal.

5.5.3 Training of operation staff

Periodical training would be provided to the staffs and operators involved in the project O&M for chemical handling, emergency, SCADA O&M, line maintenance, valve operations, electrical & mechanical operations, cleaning of sumps and SRs.

5.6 SOCIAL ENVIRONMENT

During implementation of the proposed project adequate measures will be undertaken based on the observations specific to the alignment of the pumping main.

1. It is observed that there are few common utilities like telephone cables, Electrical cables, and Water lines seen in the project area which will be shifted during construction and then replaced after the completion of work.
2. It is also verified that there will not be any possibility of cross connection with sewer line.
3. Construction will be taken place phase wise so that sections are available for smooth flow of traffic.
4. Sprinkling of water on the construction materials could minimize dust problem
5. Communication and power interruption problems could be minimized by getting proper coordination from the respective institutions
6. Green belt and growing more trees could minimize noise pollution at pumping stations.
7. Traffic could be regulated by putting caution board at appropriate locations and informing the concerned authorities.

5.6.1 Socio Economic Study

The project involves construction of 1 Head Works+ 1 WTP+3 Booster Stations + 4 Individual Sumps + 22 SRs. Of the total 31 no of sites 1 site belongs to PWD, 3 sites belongs to Revenue Department, 27 sites belongs to urban local bodies and doesn't involves acquisition of private land.

All the above sites are free from encumbrance.

Laying of Pipelines:

This sub project proposed to lay pipe lines for a total distance of 704 km of which 201.2 km belongs to State Highways Department, 4 km belongs to National Highways Department, 498.20 kms belongs to ULBs.

The average width required for laying these pipe lines are 1m and available width 1.20m. The pipe lines are proposed to be laid on the edge /carriageway of available road width and free from encumbrance. Also laying of pipe lines are proposed on the extreme boundary of the road and hence no private land acquisition is envisaged.

However, the following steps to be taken for implementation of the projects

Enter Upon Permission to be obtained for the following sites (provide details)

1. At River Tamirabarani : 1 no of Intake well cum pump house 8.00m dia and 7.00m depth,16.80m height, Pipe carrying bridge for a length of 113.4m and the transformer yard at river bank of size 20m x 10m.
2. WTP at Kondanagaram Village: Full scale Treatment with Rapid Sand Filters.
3. The water treatment plant of capacity 46.08 MLD will be constructed in Meikkal Poromboke land and it does not involve settlements and encroachments.

Booster Stations sites

Booster station-I :

- One no of sump of capacity 23.20LL, One no of sump cum pump house of capacity 2.50 LL and the transformer yard of size 20m x 10m.
- The site is to be located at Manur and the site belongs to Manur Village Panchayat. The site earmarked is vacant and the land is classified as Mayanam Poromboke land. There are no residential or sensitive areas located near Booster Station-I.

Booster station-II :

- One no of sump of capacity 23.20LL , One no of sump cum pump house of capacity 2.50 LL, and the transformer yard of size 20m x 10m.
- The site is to be located at Panavadalichatram and the site belongs to Local body. The site earmarked is classified as Kulam poromboke land.

Booster station-III :

- One no of sump of capacity 25.70LL , two nos of pum proom of size 15m x9m and the transformer yard of size 20m x 10m.
- The site is to be located at Sankarankoil. The site belongs to Sankarankoil municipality and the council resolution has been obtained from the ULB.
- Other Individual ULB Sump sites and Over Head Service Reservoirs

All the sites for the Individual ULB Sump sites and Over Head Service Reservoirs are owned by the ULBs and the council resolution has been obtained from the ULBs.

Action has been taken by the TWAD Board /ULB to obtain EUP for the above sites.

Clearances/NOC required for laying of pipe lines from various user agencies are as follows:

Southern Railways : 1 no

National Highways : 1 no

State Highways : 1 no

TNPWD : 1 no

Revenue Department : 2nos

Based on the above observations, **it may be concluded that all the identified environmental and social risks due to the construction and operation of the project have been adequately assessed and mitigated through the EMP prepared for the project and is provided in Table 6.1.** Also, adequate precautions have been built through elaborate environmental and social monitoring recommendations to provide a true picture of the performance of the project on environmental and social aspects.

Unidentified Impacts:

Any other social impacts such as encroachments, LA etc identified during implementation of the project the same will be mitigated/compensated as per ESMF entitlement matrix.

Social Categorisation:

A social screening is to be carried out for all projects funded through TNUIFSL by filling-up a social Screening form by the Urban Local Body applying for the loan. The filled-up social screening form for the proposed project is annexed as **Annexure-VII.** The social screening form was filled-up based on the assessment of project activities and their impacts on socially sensitive features. Based on the social screening form, the proposed project will have the following impacts on socially sensitive features. Depending upon the number of Project Affected Persons (PAPs) who may be affected by the project and magnitude of impact, social categorization of projects is to be carried out as defined in the ESMF and the projects will have to comply with the requirements of ESMF. ESMF categorizes the projects under category S1, S2, and S3 depending on the magnitude of social impacts.

All the lands required for the construction and operation of the components of the study are Owned by Local Body or Government Land , doesn't involve acquisition of private land and doesn't have any social impacts, hence the proposed project has been categorized as "S3" as per ESMF of TNSUDP.

5.7 ENERGY CONSERVATION

Energy conservation refers to reducing energy consumption through using less of an energy service. Energy conservation differs from efficient energy use, which refers to

using less energy for a constant service. The following points will be followed in water treatment plant and booster stations.

1. **Installation of CFL Lights:** CFL & LED bulbs cost more upfront but last 12 times longer than regular incandescent bulbs. CFL lights are proposed in meeting the lighting requirements for the project at Headworks, WTP, Booster stations, and ULB sumps.
2. **Energy Audit:** Energy audit will be conducted by energy audit experts for energy conservation technique that can help conserve energy and save good amount.
3. **Use Energy Efficient Appliances:** Some electrical appliances will be prefered to buy one with Energy Star rating. Energy efficient appliances with Energy Star rating will be consume less energy and save money.

5.7.1 Energy efficiency for pump

Below some of the energy efficiency opportunities for the pumping system will be followed.

- Bearing inspection and repair and Pump/motor alignment will be check
- Bearing lubrication will be replace, once annually or semi-annually.
- Packing seals, Wear ring, impeller and mechanical seals will be inspected and replace.
- The throttling losses will be avoid.

Pump efficiency

- The age of the pump will be caused by changes in the process and caused a mismatch between the pump capacity and its operation.
- Higher efficiency pump and motors will be used which reduces energy use.

Proper pump sizing

- A pump will be incorrectly sized it will operates under throttled conditions, the flow rate will be varies more than 30% and peak loads will be reduced,
- Economical size design of pumps has been provided which results in energy savings.

Proper pipe sizing

Energy may be saved by reducing losses due to friction through the optimization of pipe diameters. The frictional power required depends on flow, pipe size (diameter),

overall pipe length, pipe characteristics (surface roughness, material, etc.), and properties of the fluid being pumped.

Precision castings, surface coatings and polishing

The use of castings, coatings or polishing reduces surface roughness that in turn, increases energy-efficiency. It may also help maintain efficiency over time. This measure is more effective on smaller pumps.

Monitoring

Monitoring in operations and maintenance will be used to detect problems and determine solutions to create a more efficient system. Monitoring will be determine the adjusted, indicate blockage, impeller damage, inadequate suction, operation outside preferences, clogged or gas-filled pumps or pipes, or worn out pumps.

Following Monitoring will be followed in operation phase:

- Wear monitoring
- Vibration analyses
- Pressure and flow monitoring
- Current or power monitoring
- Distribution system inspection for scaling or contaminant build-up

5.8 GREEN BELT DEVELOPMENT

Green belt is proposed to implement in the project site. About 450 trees of native species are proposed to be planted. If any tree or shrub is identified to be cut the same will be removed with the approval of concerned authority.

A study on the local flora has been carried out as part of the field surveys to enable a choice of the suitable species for plantation at the project sites. The criteria for selection of species for plantation are that the species is indigenous and suited to the soil and rainfall of the area, and hardy and needs no attention after the maintenance period. Table 5.6 is gives the tree species that are suitable for plantation at the project sites.

Table 5. 6- Proposed Plantation within project Site

S.No.	Botanical name	Common name
1	*Azadirachta indica*	Neem
2	*Albizia lebbeck benth*	Vakai
3	*Polyalthia longifolia*	False Ashoka

4	*Arasa maram*	Ficus religiosa
5	*Bambusa arundinacea*	Mullumungil
7	*Thespesia populnea*	Portia tree,poovarasu
8	Peltophorum pterocarpum	Copper pod tree
9	*Delonix regia*	Gulmohar tree
10	*Cassia Fistula*	Manjal kondrai
11	*Melai azadirach*	Malaivembu
12	*Mimusops elengilinn*	Maglim
13	*Poinciana pulcherrima*	Mayuram

Details of Green Belt

The Total Green Belt Area**: 6290 Sq.m.**

No of tree to be planted = **400 Trees/Ha**

0.629 Ha trees will be planted=**252 Nos.**

Nearly 252 Nos of trees will be planted in the water treatment plant. Balance will be planted in the booster stations sites.

5.9 RAIN WATER HARVESTING

Rainwater harvesting is used for collecting and storing rainwater from rooftops and recharging ground water through pits.

- Rainwater harvesting, re-charging in to ground water provides increase of ground water table.
- Salinity of ground water is reduced.

$Qp = (1/36)\ K.P_c.A$

Q_p= Peak Rate of runoff in m^3/sec;

K= Coefficient of runoff;

A= The catchment area contributing to runoff at the considered point, in hectares;

P_c= Critical rainfall intensity of the design frequency i.e the rainfall intensity during the critical rainfall duration equal to the time of concentration, in cm/hr.

Total Roof area =1659 Sq.m

Run off coefficient = 0.85

Hourly maximum rainfall in centimetre having = 6 Cm/Hr

5 years frequency in India for Chennai Pc

$$(Q) = \frac{0.85nai\ frequ}{36} = 0.024\ m^3/sec$$

Quantity of rainfall from roof area assuming 15 minutes duration

= 0.024 *15*60

Quantity of rainfall = 21.6 m³

Pit area (Circular size pit) (filtered material) = **3.125 Sq.m**

No of pit =21.6/3.125 = **7 Nos**

i.e. 7 Nos of pits will be provided for collection of rainwater from paved area in the WTP site.

Similarly, one RWH facility is proposed in each of the project sites (BS, SRs and ULB sumps) from roof top of structures, for ground water recharge.

6. ENVIRONMENTAL MANAGEMENT PLAN

6.1 OBJECTIVES

Environmental Management Plan (EMP) is required to manage environmental impacts from the proposed project. It is a site specific plan developed to ensure that all necessary measures are identified and implemented in order to protect the environment. Site specific EMP is formulated to mitigate significant adverse environmental impacts that are identified and quantified in the process of baseline and impact assessment. An EMP also ensures that the resources are utilized to maximum extent, waste generation is minimized, residuals treated adequately and by-products are recycled to the extent possible.

6.2 ENVIRONMENTAL MANAGEMENT PLAN FOR PRE-CONSTRUCTION PHASE

Environmental Management Plan (EMP) during Pre – Construction, Construction and operation Phase is given under **Table 6.1.**

Table 6. 1-Environmental Management Plan for Pre- Construction, Construction and Operation

Sl. No.	Potential Negative Impacts	Mitigation Measures	Time frame	Responsible agencies
	Pre- Construction			
1	Clearances	All clearance required during construction will be ensured and made available before start of work. Permissions will be obtained from the concerned authority.	Before start of construction	TWAD
2	Tree cutting	Tree cutting activity in the ULB sumps and Service Reservoirs is 20. Compensatory plantation will be 10 times to the number of trees being cut.	During construction	TWAD
3	Utility Relocation	Identify the common utilities to be affected such as: telephone cables, electric cables, electric poles, water pipelines, public water taps etc. Affected utilities will be relocated with prior approval of the concerned agencies before construction starts	Before start of construction	TWAD Board / Contractor
4	Permissions from other departments	State High ways, National High Ways, other district highways, and Railway crossing for which permission was applied for a length of approximately 240 km. PWD approval for the withdrawal of 61.98MLD and pipe carrying bridge will be constructed on length of 112.90mfor river crossing.	Before start of construction	TWAD
5	Design Criteria	All the units of Head Works, treatment plant, ULBs Sumps, booster station and Pump Rooms will be designed in such a way that it can withstand maximum load and without compromising performance. The design will take into consideration all the measures identified.	Before start of construction	TWAD
	During Construction			

1	Baseline parameters	Adequate measures will be taken and checked to control the Baseline parameters of Air, Water and Noise pollution. Base line parameters recorded will be used for monitoring and conformance be ensured.	During Construction	TWAD/Contractor
2	Planning of temporary traffic arrangements	The activities are limited to the project sites and right of way. Hence does not require any traffic arrangements. In case of any need in the site, necessary permissions for temporary diversion will be obtained. Signings and safety measures including flagmen are provided at the site.	During construction	TWAD/Contractor
3	Storage of materials	The contractor will identify site for temporary use of land for construction sites / storage of construction materials, etc.	Before start of construction	Contractor
4	Construction of labour camps	i) Contractor will follow all relevant provisions of the Factories Act, 1948 and the Building and the other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 for construction and maintenance of labour camp). ii) 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. The contractor will maintain necessary living accommodation and ancillary facilities in functional and hygienic manner and as approved by the Engineer. All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. The sewage system for the camp must be planned. Adequate health care is to be provided for the work force. The layout of the construction camp and details of the facilities provided will be prepared and will be approved by the Engineer.	During construction	Contractor

		• Awareness about HIV/AIDS will be provided, grievance redressal mechanism for the camps, [only suggestion]		
5	Safety Aspects	• Adequate precautions will be taken to prevent the accidents and from the machineries. All machines used will conform to the relevant Indian standards Code and will be regularly inspected by the TWAD. • Where loose soil is met with, shoring and strutting will be provided to avoid collapse of soil. • Protective footwear and protective goggles to all workers employed on mixing of materials like cement, concrete etc. • Welder's protective eye-shields will be provided to workers' who are engaged in welding works. • Earplugs will be provided to workers exposed to loud noise, and workers working in crushing, compaction, or concrete mixing operation • The contractor will 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 Labour 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 and adhered to. • The contractor will not employ any person below the age of 18 years for any work and no woman will be employed on the work of painting with products containing lead in any form.	During construction	Contractor

6	Disposal of construction debris and excavated materials	A suitable site identified for safe disposal, in low lying areas within the project area as approved by the Engineer in charge and to other low lying area in consultation with local body.	Pre-construction and Construction	Contractor
7	Barricading site	The activities would be restricted to project sites and right of way for alignment. Barricading with adequate marking, flags, reflectors etc. will be provided along the alignment for safety of restricted traffic movement and pedestrians.	During construction	Contractor
8	Clearing of construction camps and restoration	Contractor to prepare site restoration plans, the plan is to be implemented by the contractor prior to demobilization On completion of the works, all temporary structures will be cleared away, all rubbish cleared, excreta or other disposal pits 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.	After completion of Construction	Contractor
9	Pollution from Fuel and Lubricants	i) The contractor will ensure that all construction vehicle parking location, fuel / lubricants storage sites, vehicle, machinery and equipment maintenance and refuelling sites will be located at least 500m from rivers and irrigation canal / ponds ii) All location and layout plans of such sites will be submitted by the Contractor prior to their establishment and will be approved by the Engineer iii) Contractor will ensure that all vehicle / machinery and equipment operation, maintenance and refuelling will be carried out in such a fashion that spillage of fuels and lubricants does not contaminate the ground. iv) Contractor will 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	During Construction	Contractor

		petroleum products will be disposed off in accordance with MoEF and state PCB guidelines.		
10	Pollution from Construction Wastes	All waste arising from the project is to be disposed off in the manner in consultation with TWAD Engineer	During Construction	Contractor
11	Storage of chemicals and other hazardous materials	Site identified for safe storage and handling of chemicals and other hazardous materials provided with proper display of requirements and marking as protected area.	During Construction	Contractor
12	Informatory signs and Hoardings	The contractor will provide, erect and maintain informatory/ safety signs hoardings written in English and local language, wherever required or as suggested by the Engineer	During Construction	Contractor
13	First Aid	The contractor will arrange for: i) A readily available first aid unit including an adequate supply of sterilized dressing materials and appliances as per the Factories Rules in every work zone. ii) Availability of suitable transport at all times to take injured or sick person(s) to the nearest hospital	During Construction	Contractor
14	Risk from Electrical Equipments	The contractor will take all required precautions to prevent danger from electrical equipment and ensure that- i) No material will be so stacked or placed as to cause danger or inconvenience to any person or the public ii) 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 Standard (IS) codes, will be free from patent defect, will be kept in	During Construction	Contractor

		good working order, will be regularly inspected and properly maintained as per IS provision and to the satisfaction of the Engineer		
15	Waste Disposal	i) The contractor will provide garbage bins in the camps and ensure that these are regularly emptied and disposed off in a hygienic manner as per the Comprehensive Solid Waste Management Plan approved by the Engineer. ii) Unless otherwise arranged by local sanitary authority, arrangements for disposal of night soils (human excreta) suitably approved by the local medical health or municipal authorities or as directed by Engineer will have to be provided by the contractor	During construction	Contractor
16	Environmental Monitoring	The water, air, soil and noise quality will be monitored in pre-construction and Construction phase as detailed in **Table 6.2.**	Pre-construction & Construction	TWAD & Contractor.
17	First Aid	The contractor will arrange for: • A readily available first aid unit including an adequate supply of sterilized dressing materials and appliances as per the Factories Rules in every work zone. • Availability of suitable transport at all times to take injured or sick person(s) to the nearest hospital	During construction	Contractor
18	Rainwater harvesting	Rainwater harvesting arrangements has been provided in WTP, Booster stations and ULBs sumps for collecting and storing rainwater from rooftops and recharging ground water through pits.	Construction Phase	Contractor and TWAD
19	Protection of sites	Compound wall of 2.0 m height shall be provided at all booster station, service reservoirs and WTP for protection.	Construction Phase	Contractor and TWAD
20	Accessibility to sites	Adequate road facilities have been provided in WTP, Booster stations and ULBs sumps for movement of vehicle and unloading of chemicals without disturbing of existing features and activities.	Construction Phase	Contractor and TWAD

	Head Works / WTP/Booster Pumping Station /GLSR/ ESR			
1	Protection of top soil & Environmental enhancing	Top soil from the Head works area will be stored in stock piles and that can be used for gardening purposes at Head works site which will be an environmental enhancing measure	During construction	Contractor
2	Construction of Head work and Check dam	• Coffer dams will be provided for construction of head work and check dam without any disturbance of river water flow. • After completion of work, the coffer dam and other construction debris will be removed, and river bed would be restored. • During heavy rain fall and floods when water flows with high velocity, the sluice gates in check dam are kept open.	During construction	Contractor/ TWAD/ PWD
3	Water treatment plant	• Adequate road facility has been provided inside of treatment plant for movement vehicles and heavy vehicles for unloading of chemical. • Rain water harvesting will be provided for recharging of ground water through pit. • Display boards on safety measures and emergency measures to be installed. • Regular training for the staffs operating the units of WTP with various aspects of maintaining water quality and safety. • Providing equipments like ear plugs to workers near the noise source. • Adequate stack height is given in D.G Set as per CPCB norms.	During construction	TWAD / Contractor.
4	Downstream users (impacts arising due to coffer dams, etc.)	Ensure that the flow stream is not obstructed during construction of coffer dam as directed by Engineer in charge so that there is no impact on the downstream users.	During construction	Contractor

5	Permissions from other departments	Permissions from Southern Railways, National and state Highways, TNPWD, and Revenue Department etc., will be obtained.	During implementation	TWAD
6	Tree plantation	Trees will be grown in the WTP, booster station, and other sump sites etc. Some of the trees are suggested for plantation in above sites, detail is given in **Table 5.6** of the EIA report**.**	During construction	TWAD / Contractor
		Safety in Sites		
7	Additional safety measures	The structures will be provided with easy access ladders, and handrails, interconnections between all units with proper safe walkway platforms for movement to avoid falling of human and materials. Electrical cables are going to be laid in cable trenches. Open spaces at height will be covered with parapet walls and handrails.	During construction	Contractor.
		Construction of Pumping Mains /Transmission Mains		
1	Protection of top soil	The top soil to be protected and compacted after completion of work, where the pipelines run.	During construction	Contractor
2	Laying of pipeline	• Adequate precautions will be taken while laying the water supply mains to avoid the possibility of cross connection with sewer drains. • Pumping main of 900mm diameter will be laid in Tirupanikarisalkulam pond on the right side of the road, it will be laid 2.4 m below ground level ensuring restoration of the existing bed level. • Surge protection arrangements have been provided in the clear water main at three locations in order to avoid line bursts to prevent wastage. • Air valve is provided at an interval of 500m in all transmission main to prevent leakage. • Utilities like street light etc. will be relocated without disturbing existing power lines and obtaining prior permission from concerned department.	During construction	TWAD/ Contractor

		• In the event of any damaged pipes found in the distribution system will be replaced with high density polyethylene pipes. The damaged pipes will be disposed to TSDF approved by TNPCB.		
3	Traffic diversion	• Before taking up of construction activity, a Traffic Control Plan will be devised and implemented to the satisfaction of the Engineer. • Construction will be taken phase-wise so that sections are available for traffic • Temporary diversion will be provided with the approval of the engineer. The Detailed traffic management plans prepared and submitted to the engineers for approval one week prior to commencement of works will 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 arrangements of flagmen. • The arrangement for the temporary diversion of the land will ensure to minimize the environmental impacts like loss of vegetation, productive lands etc., prior to the finalization of diversion and detours. Special consideration will be given to the preparation of the traffic control plan for safety of pedestrians and workers at night. • The contractor will ensure that the diversion/detour is always maintained in running condition, particularly during the monsoon to avoid disruption to traffic flow. He will inform local community of changes to traffic routes, conditions and pedestrians access arrangements. This plan will be periodically reviewed with respect to site conditions. • The temporary traffic detour will be kept free of dust by frequent application of water.	During construction	TWAD / Contractor

4	Temporary flooding due to excavation	Excavation during the laying of mains should be carried out with proper drainage arrangements to avoid the overflowing of existing drains.	During construction	TWAD / Contractor
5	Using of modern machineries	Using of modern machineries such as JCBs, backhoes etc, will be used to minimize the construction period, it will reduce the construction period impacts to the nearby residents	During construction	Contractor
6	Dust pollution near settlements	• All earth work will be protected in manner acceptable to the engineer to minimize generation of dust. Area under construction will be covered & equipped will dust collector. • Construction material will 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	During construction	Contractor
7	Protection of residential sensitive receptors	• Noisy construction operations in residential and sensitive areas will 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 in inhabited areas will be installed during the construction phase. • Adequate barricading / other measures to protect dust pollution near sensitive receptors like schools and hospital etc. to be ensured	During construction	Contractor
8	Vehicular noise pollution at residential /	• 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.	During construction	Contractor

	sensitive receptors	• Stationary construction equipment will be kept at least 500 m away from sensitive receptors. • All possible and practical measures to control noise emissions during drilling will be employed. The TWAD may direct to take adequate controls measures depending on site conditions.		
9	Noise from vehicles, plants and equipments	• 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 will be regular and up to the satisfaction of the Engineer to keep noise levels at the minimum.	During construction	Contractor
10	Storage of construction materials	Site for storage of pipes and construction materials to be identified, without affecting the traffic and other common utilities	During construction	Contractor
11	Pollution from Construction wastes	The Contractor will take all precautionary measures to prevent the wastewater generated during construction (e.g., during the testing of pipeline) from entering into streams, water bodies.	During construction	Contractor
12	Environmental Health and Safety.	EHS guidelines of World Bank will be complied with during construction.	During construction and post-construction	Contractor
IN OPERATION PHASE				
1	Noise Management	• The pumps will adhere to the standards of noise. Regular maintenance will be carried out to restrict the noise levels. • Provided noise control measures and Staffs entering the pump room will be provided with PPEs.	During operation	Contractor/ TWAD

		• Noise monitoring will be carried out at WTP, booster stations and ULBs sump. • Green belt is provided in WTP, booster stations and ULBs sump for reduction of noise level.		
2	Water Management	• Control valves would be provided in the inlet of all booster stations, ULB sumps and service reservoirs to control the flow. It can be used to stop the flow until the leakage is rectified. • Water meters at pumping stations are used to measure and monitor the flow. In this project, monitoring and controlling the flow in the system will be done with flow control valve with the help of SCADA system. • The backwash water is collected in the recycle sump and the solids allowed settling during one hour detention period. This settled water will be reused for green belt and dust suppression on road works. Drained Water collected from sludge drying bed will be re-circulated with raw water. SCADA system will be provided for monitoring the water treatment plant. The details on SCADA system is given in **Chapter 5.4.7**	During operation	TWAD/ Contractor
3	Soil Management	The dry sludge from the treatment plant will be stored in sludge pit and utilized for filing in low laying area in consultation with the Engineer.	During operation	Contractor/TWAD

4	Air Management	• Automatic chlorine leak detection and related alarm equipment to be installed at chlorine storage room in ULBs It is connected to a remote audible and visual alarm system and checked on a regular basis to verify proper operation. • Separate storage room provided for full, partial, or empty chlorine cylinders. • Diesel generators will be operated only for emergency power backup. The emission source diesel generators will have adequate stack height as per the norms of CPCB and regular maintenance of diesel engines has to be ensured in the Treatment Plan.	During operation	Contractor/TWAD
5	Transportation and storage of hazardous chemicals	Guidelines and procedures in Motor vehicle Act 1986 for transportation; Manufacture, Storage and import of Hazardous Chemicals Rules 1989 to be followed for storage and handling of Hazardous chemicals: Insurance covers to be taken for accidents and cost of clean-up operations.	During operation	Contractor
6	Handling of Chemicals	The unit will be provided necessary safety measures for the storage of Alum & Chlorine cylinders and provide emergency repair kit and personal safety kit like full body cover, face mask, body and eye shower etc. at the site. Eye showers one number each will be provided in chlorine cylinder storage place of ULBs (total of 6 Nos). The unit will install Chlorine gas leak detector system (Chlorine Gas Sensor) at the site.	During operation	Contractor
7	Environmental Monitoring	• The water, air noise and soil quality will be monitored periodically. • The water quality will be monitored at various points prior to distribution – head work, treatment plant, clear water sump and booster stations, etc. • Monitoring of noise levels will be carried out at head work, WTP, and booster stations. • Detailed monitoring record will be maintained. Periodical report will be send to the Engineer. The frequency and parameters for	During operation	TWAD & Contractor.

		Environmental Monitoring detail is given in Table 6.3 of the EIA report.		
8	Other Management measures at Sites	• Providing equipments like ear plugs to workers near the noise source. • Providing PPEs for safe working of personnel in critical areas like chlorination plant will be ensured. • Display boards on safety measures and emergency measures to be installed. • Regular training for the staffs operating the Head Works with various aspects of maintaining water quality and safety. • PPEs for the workers exposed to high noise. • Regular maintenance of the greenbelt and landscaping made at the project sites with watering, manuring, pruning etc.	During operation	TWAD & Contractor
9.	Online Monitoring System through SCADA	Installation of SCADA System for online monitoring at the Head works, Booster stations, ULBs sumps, Service Reservoirs and at the Major tapping points or Branch point and gathering the real time data from remote locations. The details of SCADA is given in Chapter 5.3.7.	Operation Phase	TWAD/Contractor
10	Training for staff	Periodical training would be provided to the staffs and operators involved in the project O&M for chemical handling, emergency, SCADA O&M, line maintenance, valve operations, electrical & mechanical operations, cleaning of sumps and SRs.	During Operation	TWAD / Contractor.
11	O&M Measures	• Rain water harvesting structures, sludge drying pits, Sumps and WTP units shall be cleaned periodically. • Periodically inspection of Pump/motor, Wear ring, impeller and lubrication, alarm systems. • Repair and renewal of Mechanical & electrical equipments, civil works etc.,	During Operation	Contractor/TWAD

12	Water Treatment Plant	• The backwash water is collected in the recycle sump and the solids allowed settling during one hour detention period and will be recirculated into the treatment unit, besides this will also be reused for green belt. • On-line monitoring through SCADA is proposed which would prevent overflow and wastage water. • Dried Sludge will be stored in sludge pit and utilized for filing in low laying area.		

6.3 ENVIRONMENTAL MONITORING PLAN

Environmental Monitoring Plan of construction and operation phase is given in **Table 6.2 & 6.3.**

Table 6. 2- Environmental Monitoring Plan Pre-Construction &Construction Phase

Attributes	Parameters	Frequency	Location	Responsible Agency
Pre-Construction & Construction Phase				
Air Quality	PM_{10}, $PM_{2.5}$, SO_2, NO_x, CO and Pb (standards as per CPCB)	Seasonal Sampling	Treatment Plant-Kodanagaram Booster stations - 3 nos ULB sumps – 5 nos Other places of work	Contractor through approved monitoring agencies
Water Quality	Drinking water standards as per IS 10500:2012.	Seasonal Sampling	Head works WTP – inlet and outlet Booster stations - 3 nos ULB sumps – 5 nos	Contractor through approved monitoring agencies
Noise Level	Noise level on dB (A) scale noise levels on dB (A) scale (as per MoEF Noise Rulers, 2000)	Seasonal Sampling	Treatment Plant-Kodanagaram Booster stations - 3 nos ULB sumps – 5 nos Other places of work	Contractor through approved monitoring agencies
Soil Quality	Monitoring of Pb, sar and Oil & Grease (standards as per TNPCB)	Seasonal Sampling	Treatment Plant-Kodanagaram Booster stations - 3 nos ULB sumps – 5 nos Other places of work	Contractor
Health	All relevant parameters including HIV	Regular check-ups as per Factories Act		Contractor

Table 6. 3- Environmental Monitoring Plan Operation Phase

Attributes	Parameters	Frequency	Location	Responsible Agency
Operation Phase				
Air Emissions	PM_{10}, $PM_{2.5}$, SO_2, NO_x, CO and Pb (standards as per CPCB) Stack monitoring for D.G.Sets	Seasonal Sampling (3 times a year)	Headworks Treatment Plant-Kodanagaram Booster stations - 3 nos ULB sumps – 5 nos	Implementing Agency
Water Quality	Drinking water Standards as per IS 10500:2012.	Seasonal Sampling (4 times a year)	WTP - Inlet and Outlet (2 nos) ULB sumps – Outlet (6 nos)	Implementing Agency
Noise Level	Noise level on Db (A) scale noise levels on dB (A) scale (as per MoEF Noise Rulers, 2000)	Seasonal Sampling (4 times a year)	Headworks Treatment Plant-Kodanagaram Booster stations - 3 nos ULB sumps – 5 nos	Implementing agency
Soil quality	Monitoring of Pb, sar and Oil & Grease	Seasonal Sampling (4 times a year)	Treatment Plant-Kodanagaram	Implementing Agency
Health	All relevant parameters (BP, Sugar, chest X-ray, Eye vision, etc.)	Regular checkups as per factories act.		Implementing Agency
Safety Monitoring	First Aid, replacement of PPE	Yearly	Treatment Plant Kodanagaram & Booster station	Implementing Agency
Green Belt Development	No. of plants, species, survival status	Once a year	Treatment Plant Kodanagaram & Booster station	Implementing Agency

6.4 EMP COST

Table: 6.4 - EMP Cost of the Project

Sl No	Description	Amount In Lakhs	Remarks
1)	**HEAD WORKS-**		
A	Coffer Dam including removal of debris	**2.26**	Included in BOQ
2)	**RAW WATER MAIN**		
a)	Restoration of Concrete Road	**1.10**	Included in BOQ
b)	Restoration of Existing pipe (Damaged pipe)	**1.80**	Included in cost estimate
3)	**CLEAR WATER MAIN**		
b)	Restoration of Existing pipe (Damaged pipe)	**6.45**	Included in cost estimate
4)	**TREATMENT PLANT**		
a)	Recirculation Arrangements, sludge drying bed and Sludge Pit	**75.59**	Included in BOQ
b)	Provision for landscaping and greenbelt	**5.00**	Included in BOQ
c)	Development of green belt	**0.20**	Included in BOQ
d)	Construction of Compound Wall around Treatment Plant	**23.50**	Included in BOQ
e)	Septic Tank with Pipe connection works	**0.98**	Included in BOQ
f)	Automation Works (Back wash & Recycling)	**112.56**	Included in BOQ
5)	**Booster Station** at Manur, Panvadalichatram, Sankarankoil, and ULBs Sump At Puliyankudi,Rajapalayam,Sivakasi,Thiruthankal & Thiruvenkadam.		
a)	Construction of Compound wall	**18.20**	Included in BOQ
b)	Greenbelt /Gardening for reducing the noise	**0.12**	Included in BOQ
c)	Chlorine Leak Detection/Alarm eye showers Mask with Cylinder etc at ULB sumps.	**---**	Included in Technical Specification for Chlorinators
6)	**ELEVATED SERVICE RESERVOIRS**		
a)	Construction of Compound wall	**55.80**	Included in BOQ
7)	Distribution System		
b)	Restoration of road surfaces for the proposed Distribution system	**353.48**	Included in BOQ
8)	**Others**		

a)	Provision for shifting of utilities	**---**	Included in project estimate
b)	Disposal of excavated excess earth and construction debris		Included in BOQ
9)	Barricading for Pipe line works including watch and ward showing danger Lights etc		Included in general Specification for Pipe laying works
10)	Rain water Harvesting Structures	**7.71**	Included in BOQ
11)	Online monitoring for efficiency in the project and management of resources through SCADA	**421.00**	Included in BOQ
12)	Monitoring as per Table 6.2 & 6.3		Included in O&M cost estimate
13)	Energy Efficient Lightings		Included in BOQ

7. PUBLIC CONSULTATION

As per the World Bank policy on access to information and disclosure, the proposed project attracts Public Hearing. The Public Hearing was arranged by TWAD Board officials at beneficiary Municipalities and Town Panchayat. The concerned persons having plausible stake in environment aspects were requested to attend the meeting.

Information on Public Consultation were informed explicitly to the stake holders/beneficiaries concerned in all the municipalities notifying the date and time in newspapers, pamphlets, issuing notices door to door and keeping displays etc,.

The public consultations were presided over by respective Chairman of beneficiary Municipalities and Town Panchayat. The members from TWAD Board explained the salient aspects of the proposed project during the meeting through power point presentation. The stake holders/beneficiaries were asked to offer their views on the proposed project. ULB public consultation, date and venue details are given in **Table 7.1** and public consultation Canvassing Photos and Newspaper notification, Minutes of the meetings held at beneficiary Municipalities and Town Panchayat are enclosed in **Annexure –IX.**

Table 7. 1: ULB Public Consultation, Date and Venue

ULB	DATA	VENUE
Sankarankoil	20.08.2016	Municipal council Hall
Puliangudi	04.07.2016	Municipal council Hall
Rajapalayam	10.08.2016	Municipal council Hall
Sivakasi	12.07.2016	Municipal council Hall
Thiruthangal	08.07.2016	Municipal council Hall
Thiruvenkadam	08.07.2016	Community Hall

7.1 OUT COME OF PUBLIC CONSULTATION

The Participants at the public consultation were keen on the following aspects:

- Time frame of the proposed project and date of commissioning
- Amount to be paid as water tax after the implementation
- Maintenance during operation of the proposed project
- Various components of the proposed water supply scheme

It was evident from the public consultation that the people are eagerly awaiting for the early implementation of the project. The public also expressed their grievances on present water scarcity and assured complete support during the implementation of this much awaited water supply scheme in their respective Municipalities and Town Panchayat.

8. IMPLEMENTATION AND INSTITUTIONAL ARRANGEMENTS

The proposed project is to provide a Combined Water Supply Scheme to five Municipalities including Sankarankoil, Puliyankudi Municipalities and Thiruvenkadam Town Panchayat in Tirunelveli district, Rajapalayam, Sivakasi, Thiruthangal Municipalities in Virudhunagar district with River Tamirabarani as source. This project will be implemented by TWAD under the scheme of Tamil Nadu Sustainable Urban Development Project (TNSUDP) at an estimating cost of Rs.543.20 Crores.

The project is proposed to be implemented by TWAD through Prospective contractor. The environmental management plan identified for the construction will be included in the bid documents for ensuring implementation of the environmental safeguards. Implementation of the management measures by the contractor will be ensured by TWAD Board and report on ESMF compliance will be submitted to TNUIFSL periodically.

The management measures identified for operation phase will be taken up by the Prospective contractor upto maintenance period and beyond that by TWAD Board.

8.1 GRIEVANCE MECHANISM

TWAD Board has proposed to provide a Combined Water Supply Scheme to five Municipalities including Sankarankoil, Puliyankudi Municipalities and Thiruvenkadam Town Panchayat in Tirunelveli district, Rajapalayam, Sivakasi, Thiruthangal Municipalities in Virudhunagar district. The management measures identified for the operation phase will be taken up by the TWAD Board upon completion of construction activities.The TWAD Board will have Grievance Redressal mechanisms to handle the grievances of the project.A project level grievance Redressal committee will be set up and the members are as follows (preferably one of them as women)

1. Executive Engineer (Projects –TWAD Board)
2. Commissioner (For respective Urban Local Body)
3. A person who is publicly known in the local area

TWAD Board will submit monthly reports on the status of compliance with the ESMF requirements to TNUIFSL.

9. PROJECT BENEFITS

9.1 PRESENT SCENARIO

The existing sources (local sources and Kottamalaiyar) to Sankarankoil and Puliyankudi Municipalities are not sustainable during summer periods. The Mudangiyar & Malattar sources of Rajapalayam Municipality WSS, Vembakottai & Vaippar sources of Sivakasi Municipality WSS and Bore well, open well in Anaikuttam sources of Thiruthangal Municipality WSS are not dependable for further requirement. During the summer season, all the local sources in Thiruvenkadam Town Panchayat are depleted and the water supply is being met only through Manur CWSS and the present per capita supply level is50 lpcd. Considering the Population growth and as per present norms, it has been proposed to step up the service level from 90 lpcd to 135 lpcd taking into account of proposed UGSS to these 5 Municipalities.

Thus this proposed project will increase the service level of water from 90 lpcd to 135 lpcd in Municipalities and 70 lpcd to 90 lpcd in Town Panchayat.

9.2 PROJECT BENEFITS

The purpose of this project is to supply water from Tamirabarani River to the water scarce areas. The detailed water requirement and proposal to each of them are as follows:

a) Sankarankoil Municipality

At present 6.87 MLD of water is being supplied through four existing service reservoirs. It is proposed to construct 3 Nos. of service reservoirs additionally in the following places:

i. 3.00 LL service reservoir in Ward No.10
ii. 3.00 LL service reservoirin Barathiyar Street
iii. 3.70 LL service reservoir in Puliyankudi road

After the implementation of the scheme in this region, it is proposed to supply the balance requirement of 3.53 MLD for the intermediate year (2032) and 5.96 MLD for ultimate year (2047).

b) Puliyankudi Municipality

At present 4.20MLD of water is being supplied through five existing service reservoirs of Puliyankudi Municipality. It is proposed to construct 4 Nos. service reservoirs additionally in the following places:

i. 4.00 LL service reservoir near Government Hospital
ii. 4.00 LL service reservoir in RSKP
iii. 2.30 LL service reservoir in Chinthamani
iv. 0.70 LL service reservoir in Ayyapuram

After the implementation of the scheme in this region, it is proposed to supply the balance requirement of 6.87 MLD for the intermediate year (2032) and 9.03 MLD for the ultimate year (2047)

c) Rajapalayam municipality

Presently Rajapalayam municipality is supplied with 2.99MLD of water from the existing bore wells and open wells. In the Rajapalayam Municipality seven numbers of Existing Service Reservoir are available. It is proposed to construct seven more numbers of Service Reservoir of various capacities in various locations of Rajapalayam Municipality as detailed below.

i. 4.00 LL service reservoir in Ambedkar Nagar
ii. 5.00 LL service reservoir in Kulalar street
iii. 6.00 LL service reservoir in Kamarajar Nagar
iv. 6.80 LL service reservoir in Kamarajar Nagar
v. 7.00 LL service reservoir in Zone 12 near Mother Health care
vi. 8.40 LL service reservoir in Kamarajar Nagar
vii. 11.40 LL service reservoir in Madurai road

After the implementation of the scheme in this region, it is proposed to supply the balance requirement of 14.28 MLD for the intermediate year (2032) and 19.01 MLD for the ultimate year (2047).

d) Sivakasi Municipality

At present, 4.50 MLD of water is being supplied through eight existing service reservoir Sivakasi Municipality. It is proposed to construct 2 more numbers of Service Reservoir of various capacities in various locations of Sivakasi Municipality as detailed below.

i. 4.00 LL service reservoir near RC Church (Zone 2).
ii. 3.80 LL service reservoir near Children health centre(Zone 10)

After the implementation of the scheme in this region, it is proposed to supply the balance requirement of 8.33 MLD for the intermediate year (2032) and 10.62 MLD for the ultimate year (2047)

e) Thiruthangal municipality

Presently Thiruthangal municipality isbeing supplied with 3.50MLD of water.It is proposed to construct 2 more numbers of Service Reservoir of capacity of 4.0 LL – 1No and 1.80 LL – 1No. After the implementation of the scheme in this region, it is proposed to supply the balance requirement of 6.22 MLD for the intermediate year (2032) and 8.11 MLD for the ultimate year (2047)

f) Thiruvenkadam Town Panchayat

Present water supply of 0.45MLD is being supplied under 2 schemes. After proposed water supply scheme one new reservoir station of 0.60 LL capacity at Thiruvenkadam will be added to Thiruvenkadam town Panchayat.After the implementation of the scheme in this region, it is proposed to supply the balance requirement of 0.66 MLD for the intermediate year (2032) and 0.93 MLD for the ultimate year (2047).

The Water supply in the study area continues to be inadequate, despite longstanding efforts by the various levels of government and communities at improving coverage. The proposed project is an innovative and demand-driven approach to improve the water supply in the study area. Hence the implementation of this project will definitely assure improved access to water in the water scarce area.

10. CONCLUSION

The proposed project envisages combined water supply to Sankarankoil, Puliyankudi, Sivakasi, Thiruthangal & Rajapalayam Municipalities and Thiruvenkadam Town Panchayat throughout the day with source as River Tamiraparani. Water treatment plant at Kondanagaram is proposed to make it more acceptable as per drinking water standards. The treated water is pumped with the help of 3 booster stations and then taken to Service Reservoirs through distribution networks connecting them. The implementation and maintenance of the project has no major adverse impact on environmental components either in planning or during the constructional phase. The likely impact arising out of the project is discussed in depth and recommended for mitigation.

In general, the project as a whole is a warm welcoming scheme and will have positive impact on the people of the area who were longed for the dependable and potable water.