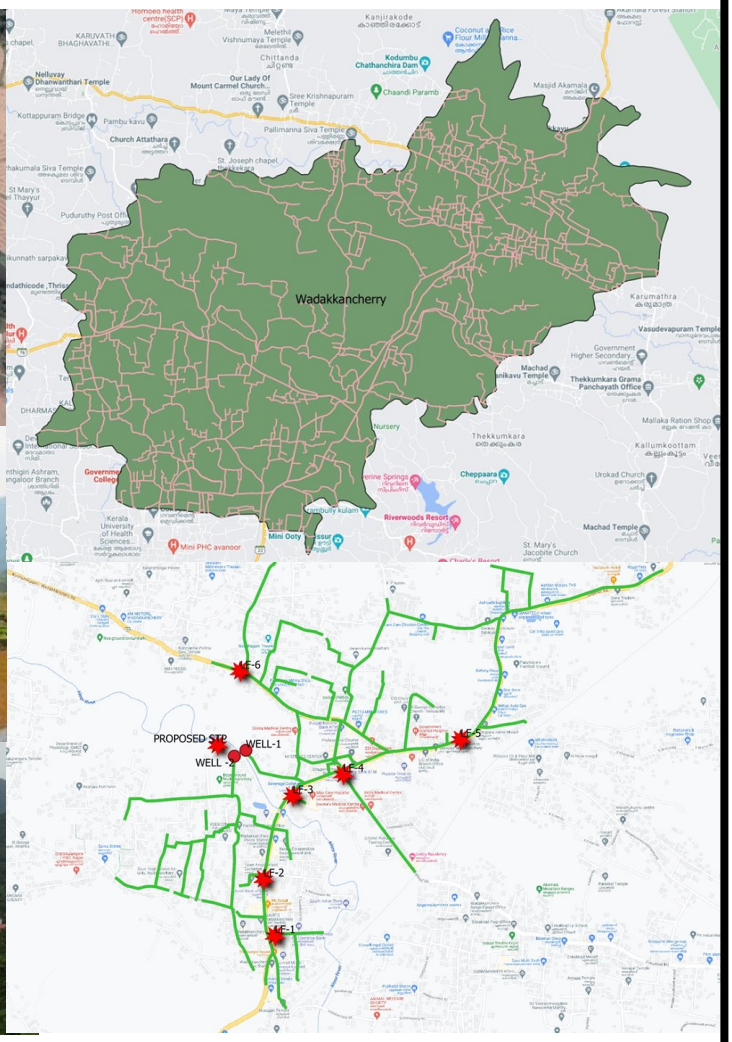
KERALA WATER AUTHORITY

DETAILED ENGINEERING REPORT



1.35 MLD CAPACITY SEWERAGE SYSTEM FOR

WADAKKANCHERY MUNICIPALITY

Prepared by:
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EXECUTIVE SUMMARY

The detailed engineering report has been prepared for providing a Sewage Treatment Plant (STP) for Wadakkanchery Municipality in Thrissur District. As an initial part of the study, the Sewerage vertical team of Kerala Water Authority visited the Municipality and conducted several discussions with the authority and collected all basic data and information for design of the system. Detailed Discussion were done with the officials involved in the project and visited site proposed for the Sewage Treatment Plant (STP). At present there is no planned sewage treatment facility for the entire project area. Under the above circumstances it has been planned to construct a STP for the liquid waste management within the project area covering core area of the town with sewage network and other portions with septage management.

The sewage and sullage load generated for the project area was determined from the water consumption analysis and expected future requirements was also considered. It is observed that 1.35 Million Liters per Day (MLD) capacity STP is required including septage for Wadakkanchery Municipality and the unit operations, and the chemical and biological process were designed in accordance with all stipulations of accepted practice of design and Indian Standard Codes of practice. The effluent characteristics were adopted in accordance with the regulations, especially the NGT guidelines on it. The biological treatment unit consists of Moving Bed Biofilm Reactors (MBBR) with a facility for nitrification and de-nitrification also. For additional purification, clarifiers are designed as a modern plate settler. Total estimated cost is observed to be **Rs. 43,28,58,000 (Forty Three Crores Twenty Eight Lakhs Fifty Eight Thousand Only)** including 10 years operational expenses excluding power charges. The plant is to be equipped with sludge handling and disposal units also. It is planned to provide ecofriendly units for the system with gardens especially for the exterior portions of the units. For conserving energy and optimizing performance of the system solar energy source is also planned to be used. Also, for trouble free performance of the system, at all points of influence, sensors for measuring values of flow and required parameters are to be installed. Using Internet of Things (IoT) enabled software system, the control of the entire process can be performed effectively. It has been planned to implement the project within a short span of time.

PROJECT AT A GLANCE

Sl. No.	Item	Description
1	Name of Project	1.35 MLD Capacity Sewage Treatment Plant and Sewerage System for Wadakkanchery Municipality
2	Name of District	Thrissur
3	Project area	Wadakkanchery Municipality
4	Capacity of STP	1.35 MLD
5	Components	Pre-treatment units, Co-treatment units for Septage, MBBR, Clarifier, Filters, Sludge handling units
6	Project cost (including 10 years O&M cost)	Rs. 43,28,58,000
7	10 year operational and maintenance cost	Rs. 11,09,10,000
8	Implementation agency	Wadakkanchery Municipality
9	Period of execution	24 Months

ABSTRACT OF ESTIMATE

ABSTRACT OF COST		
Sl. No.	ITEM	AMOUNT
CIVIL ITEMS		
1	Site Preparation-LS	₹ 5,000
2	OG Trap, Receiving Chamber, Screen, Grit Chamber	₹ 36,79,575
3	Equalisation Tank	₹ 38,30,105
4	Dilution Tank for Co-treatment	₹ 12,98,720
5	Moving Bed Biofilm Reactors	₹ 66,59,946
9	Clarifier with Tube/Plate Settler	₹ 13,04,007
10	Sludge Sump and Thickener	₹ 7,07,685
11	Chlorine Contact Tank and Filter Feed Tank	₹ 9,90,224
12	Treated Water Tank	₹ 7,58,410
13	Green Belt and Landscaping	₹ 11,55,000
14	Facility for Recycling Purposes	₹ 1,50,000
15	Building with Trussed Roof and Eco-friendly walls	₹ 42,42,500
16	Equipment, Laboratory items, Furniture and Computer	₹ 6,00,000
17	Sewer network with pipelines and chambers	₹ 19,03,16,567
	TOTAL OF CIVIL ITEMS	₹ 21,56,97,739
	GST Component (18%)	₹ 3,88,22,126
MECHANICAL ITEMS		
1	Gates and Screens	₹ 2,25,000
2	Pump sets and Aeration system	₹ 61,95,584
3	PSF & ACF	₹ 35,50,000
4	Centrifuge	₹ 4,00,000
5	Bypass arrangements, steel ladder and frame work	₹ 3,50,000
6	MBBR Carrier and other items	₹ 65,89,720
7	Tube settler media	₹ 2,02,635
8	Alum and Lime dosing systems	₹ 1,60,000
9	Odour Control Unit	₹ 60,000
10	GPS fitted Vacuum Trucks	₹ 90,00,000
	TOTAL OF MECHANICAL ITEMS	₹ 2,67,32,939
	GST Component (18%)	₹ 48,11,929
ELECTRICAL ITEMS		
1	Interconnecting piping system	₹ 4,50,000
2	Diesel Generator	₹ 8,40,000
3	Electrical works, IoT based sensor and control units	₹ 15,25,000
4	Electrical installations for lifting stations and collection wells	₹ 3,00,000
5	Installation of solar units for lifting stations, wells and STP	₹ 11,60,000
	TOTAL OF ELECTRICAL ITEMS	₹ 42,75,000
	GST Component (18%)	₹ 7,69,500
ABSTRACT OF COST		
Sl. No.	ITEM	AMOUNT
1	Civil Works	₹ 21,56,97,739
2	Mechanical Works	₹ 2,67,32,939
3	Electrical Works	₹ 42,75,000
	Total Project Cost	₹ 24,67,05,678
	GST Component (18%)	₹ 4,44,03,556
	DPR preparation charge @ 2.5%	₹ 61,67,642
	Centage charges@10%	₹ 2,46,70,568
	Unforeseen	₹ 556
	GRAND TOTAL	**₹ 32,19,48,000**
	(Rs. Thirty Two Crores Nineteen Lakhs Forty Eight Thousand Only)	
	Total O&M cost for 10 years	₹ 11,09,10,000
	TOTAL COST including 10 years O&M	**₹ 43,28,58,000**
	(Rs. Forty Three Crores Twenty Eight Lakhs Fifty Eight Thousand Only)	

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND AND PROJECT GENESIS

Kerala Water Authority (KWA) was established on 1st April 1984 under the Kerala Water and Wastewater ordinance, 1984 by converting the erstwhile Public Health Engineering Department to provide for the development and regulation of water supply and wastewater collection and disposal in the State of Kerala and for matters connected there with. To effectively address the emerging need of wastewater management, a Sewerage Vertical wing has been created in KWA with Chief Engineer, PPD, WASCON and Sewerage as its head.

KWA as a knowledge partner, service provider and a central agency for coordinating the activities related to the planning and implementation of sewerage systems for Local Self Government Institutions (LSGIs) can contribute in many ways. In the State of Kerala, KWA is providing sewerage system partly in Thiruvananthapuram and Kochi Corporations and a Sewerage system for Guruvayur Municipality has been completed.

1.2 NEED FOR A SEWAGE TREATMENT SYSTEM

Environment protection has become the most important aspect in the present era of sustainable development. With uncontrolled urbanization, contamination of drinking water sources by sewage and septage has become a major threat to public health and safety. Direct discharge of sewage to the water courses and discharges of septic tank effluents to the stream and canals polluted the entire water course. Safe water supply and hygienic sanitation facilities are the two basic essential amenities for healthy living. In the developing world, sanitation has always been more unfortunate than its twin brother water supply. The water supply will have a measurable impact on health only if it is linked with sanitation facilities.

The objective of the present work is to prepare a Detailed Engineering Report (DER) and implementation of an STP for Wadakkanchery Municipality in Thrissur district. The major objective of establishing Sewage Treatment Plant is to treat the effluent (untreated wastewater) generated from core areas of the town and to avoid its direct release into natural environment. Wastewater may have an adverse impact on human health and environments. Therefore, proper wastewater management in this municipality is essential. Other general objectives of the present works are:

1. To find appropriate methods for collection, treatment and disposal of wastewater generated from the project area of Wadakkanchery Municipality.
2. Treat all the wastewater generated from houses, commercial establishments and public institutions etc. as per the norms laid by Pollution Control Board and other regulations.
3. To discuss possible options to improve management of wastewater in the project area.

1.3 HUMAN DEVELOPMENT OUTCOMES FOR SEWERAGE INVESTMENTS

Lack of access to improved sanitation costs countries up to 7% of their GDP annually. At the national and global levels, the human cost manifests in huge economic losses. These losses are mainly driven by premature deaths, health care treatment, lost time and productivity seeking treatment, and finding access to sanitation facilities in urban areas and thickly populated clusters of rural areas as well. In 2012, the World Health Organization (WHO) estimated that the global economic return on sanitation spending is US $5.5 for every one dollar invested, more than double the economic return on water spending (US$2.0). However, the UN 2012 Global Analysis and Assessment of Sanitation and Drinking Water indicates that only 10 out of 75 countries who participated in their survey reported to have more than 75% of the funds needed for sanitation.

Investment in safe water supply and access to improved sanitation has multiple economic returns. For every 1 US Dollar invested, there is a projected USD 3 to 34 benefits gained. The benefits range from time savings and productivity gains to budget savings on health-care. Per capita gains for the developing world population could reach at least USD 15 per capita per year. It is well established that aspects of women safety, dignity and well-being are intrinsically linked to improved availability, access and use of sanitation and drinking water facilities.

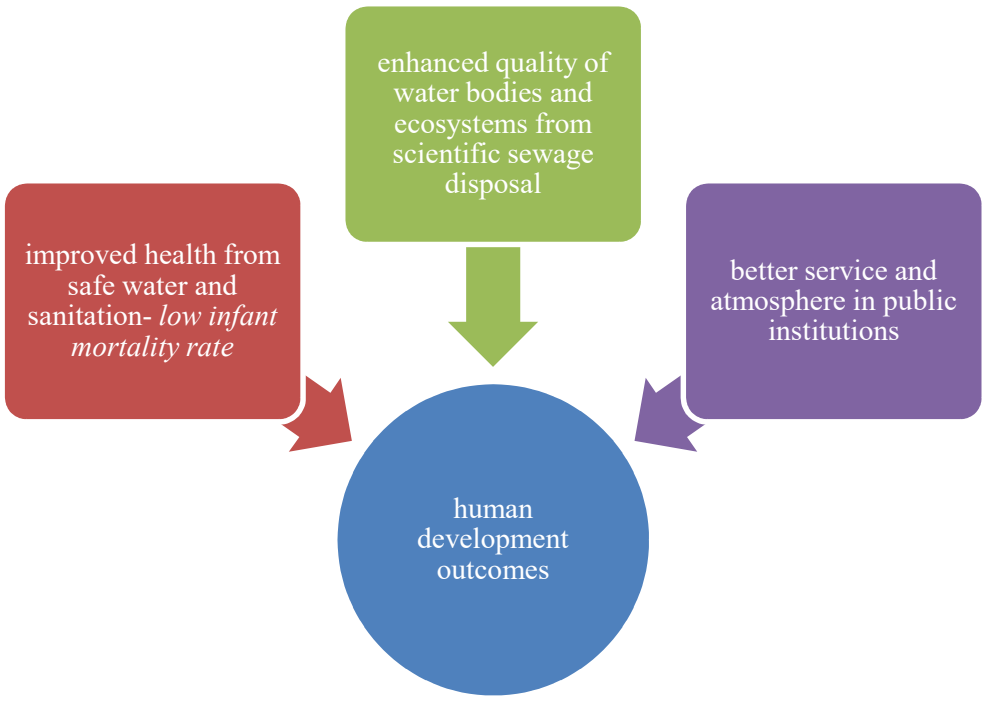


Fig.1 Human development outcomes for sewerage investments

1.4 OVERVIEW OF SITUATION AND GOALS

Wastewater disposal and treatment was a major problem in cities in Kerala. The wastewater from toilets has been disposed through septic tanks and soak pits and grey form of wastewater from kitchen and bathrooms is directly discharged into the sludge drains without any treatment. As per Census 2011, 45.455 of the urban households have “no drainage”. There are 14.32% of the households connected to centralized sewerage system. Although centralized sewer system is of minor importance and disposal of sludge is a problem.

About 97.43% of the households in the urban areas of Kerala state have a toilet within their residential premises. Almost 56.69% of them are connected to septic tanks, 21.87% to pit latrines while households having connection to the centralized sewer system are about 14.32%. There are both technical and institutional dimensions to the problem of septic tanks in the state of Kerala. The septic tanks design does not comply with the national guidelines with reference to planning, design and construction. Local masons are unaware of the existing design and construction guidelines to construct and design the septic tanks. There are multiple agencies involved in operation and maintenance of water and sanitation services in Kerala. Septage management is viewed as private provision with limited role of urban local bodies.

The districts with highest percentage of households using septic tanks are Kozhikode (69.51), Wayanad (63.20), Malappuram (62.30), Kannur (60.24) and Thrissur (60.10). Together, these five districts account for 50.38 percent of the total households using septic tanks in the state of Kerala. About 50.78 percent of households in Census Towns use septic tanks for the purpose of faecal sludge management at the household level. Municipal Corporations and Municipalities have 29.40 and 19.82 percent respectively of the households having septic tanks.

The Service Level Benchmark (SLB) is to ensure that all households have access to sewerage connection to ensure that the faecal sludge is safely disposed and treated at the Sewerage Treatment Plant (STP).

Another set of reasons cited for urgency in taking up septage management is the occupational hazards for emptying the septic tanks. The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013 has expanded the definition of workers engaged in such sanitation works by including the practice of septic tank emptying and manual handling of such faecal sludge. The revised Manual Scavenging Act will require states to gear up the Municipal bodies in discharging their responsibilities effectively.

In the absence of efficient water treatment systems and solid waste management systems, untreated domestic and industrial wastes, and agriculture-runoff flow into the rivers polluting the rivers in Kerala. There has been widespread bacteriological contamination of faecal origin in ground and surface water which relate to proximity of increasing numbers of leach pit latrines, leakages from septic tanks, washing, bathing and other domestic activities.

Hence the goals for setting a sewerage strategy for a district will involve multi-faceted approach to cover every habitation and other institutions and establishments. This will render adequate results in both short term and long-term development plans. If a plan has been chalked out which can provide a systematic and flexible implementation mode, stage by stage implementation and better control over the system can be achieved. A district level plan document for sewerage will create a backbone for the subsequent formation of detailed engineering reports in this regard. Hence implementation of sewerage systems at the local body level will be more effective and systematic.

1.5 VISION OF SEWERAGE STRATEGY

As per the vision of Kerala State Sanitation Strategy, all cities and towns in Kerala become totally clean, sanitized, healthy, liveable, ensuring and sustaining good public health and environmental outcomes for all citizens, with a special focus on hygienic and affordable sanitation for the urban poor and women with specific focus on the diverse topography of the state and its implications. Hence the overall vision can be defined as the achievement of an urban Kerala ensuring environmentally safe disposal of solid and liquid waste. Similarly, to formulate a vision for sewage strategy for each habitation of the State it is imperative to develop a scientific, sustainable and effective sewage system covering directly or indirectly every human settlement. Improved Institutional governance and enhanced human resource capacities for planning and maintaining the sewerage is also coming under the goal. Capacity building for adoptability to modern technologies and applications for the service providers is also another goal.

1.6 ORGANIZATION OF DETAILED ENGINEERING REPORT

The Detailed Engineering Report (DER) for the Sewage Treatment Plant and Sewer Network for Wadakkanchery Municipality in Thrissur District has been prepared by KWA and presented in 7 chapters, describing different project concepts and activities.

Chapter 1 deals with a general introduction to the subject. Vision and goals of the sewerage for entire project area and its social implications are described.

Chapter 2 consists of various aspects of the sewerage strategy for the project area. Plan for the sewerage treatment and the technology adopted are described.

Chapter 3 describes sewer network in details. Planning of sewer network in core areas and its design is illustrated in detail.

Chapter 4 deals with the unit operations and treatment process in details. Various components of the sewerage system and its design aspects are also described in detail.

In Chapter 5, detailed estimates for all components of the sewerage project are illustrated.

Chapter 6 deals with various aspects of operation and maintenance of the sewage treatment plant in detail. Since it is decided to impart optimum cost and functional aspects of operation, applications of modern technologies for control of the process are also dealt with.

In the concluding Chapter 7, observations gathered from the pre-feasibility studies for the planning, design and implementation of the sewerage system for the institution is presented. Action plan for the implementation of the project and recommendations for future additions are also dealt with.

CHAPTER 2

PLAN OF SEWAGE TREATMENT

2.1 GENERAL

In this Chapter general aspects of sewage collection, treatment and disposal for the Wadakkanchery Municipality is described. For core area of the Municipality, sewer network consisting of pipeline network is planned to be laid underground to collect sewage load from various nodes in the system across the project area. The sewage network system also consisting of manholes at the interval of 30 m in normal cases and at every bends in vertical and horizontal planes. Whenever there is a variation in diameter, manholes are also provided. To reduce depth cutting, lifting manholes are provided with sewage lifting pumps of smaller capacities. Solar power and diesel generator backup power is also provided to get uninterrupted working of the system. IoT enabled monitoring of the sewerage system is envisaged with a control station inside the Sewage Treatment Plant (STP).

The locations in the project area without having sewer network are included in the septage management plan. Using septage transportation system, sludge from various points is collected and diluted using co-treatment facility at STP area and treated along with sewage.

Sewage Treatment Plant is designed for primary treatment and subsequent bacteriological and chemical treatment process. Finally, sludge handling units are planned to be provided. The recycled water can be taken for agricultural and other commercial and industrial purposes and for recharging water bodies and to alleviate any pollution loads.

2.2 PROJECT AREA

Thrissur District is situated in south-western India (10.52°N 76.21°E) and is in the central part of Kerala. Thrissur is at sea level and spans an area of about 3,032 sq.km. It is bounded on the north by small parts of Malappuram district, on the east and north by Palakkad district, on the east by small parts of Coimbatore district of Tamil Nadu, on the south by Ernakulum district, and on the west by the Arabian Sea (54 km). Descending from the heights of the Western Ghats in the east, the land slopes towards the west forming three distinct natural divisions – the highlands, the plains and the seaboard.

Wadakkanchery is a major town in Thrissur, Kerala and lies between 10°39′34″N 76°14′58″E and10°39′34″N 76°14′58″E. Up until 1860, this area was part of Chelakkara Taluk. Now, it is the headquarters of Thalappilly Taluk with an area extend 51.56 sq.m. As per Census 2011 Wadakkanchery Municipality has a population of 61341 with 29369 Men, and 31972 Women Wadakkanchery obtained municipality status from the government by merging with the Mundathikode panchayath in 2015 and it is the only town in Thrissur District to be raised as municipality recently.

Wadakkanchery is situated on the Thrissur–Shornur State Highway 22 and is directly connected to Kunnamkulam (another major town in the Thrissur district). Ottupara Bus Stand is a main stop on the Thrissur–Ottapalam/Chelakkara bus route. Railway Station is in Wadakkanchery and is managed by Southern Railways. Being one status of Adarsh station by the government of India, it is the main station after Thrissur Railway station.

Wadakkanchery is an important cultural centre. The Kerala Kalamandalam is located at Cheruthuruthy, not far from Wadakkanchery. This place is home to many artists, literary and cinema figures. Government Boys' High School, Government Girls' High School, St. Pius, and Bharathiya Vidya Bhavan are the premier schools located at Wadakkanchery. Sri Vyasa NSS College, managed by the Nair Service Society, at Parlikkad is a noted educational institution near Wadakkanchery. Parlikkad also hosts a major religious congregation of Hindus during December of every year.

The Vazhani Dam, approximately 8 km from Wadakkanchery, made entirely of mud is the major tourist attraction nearby. Wadakkanchery is situated in the heart of the "Pooram belt". Poorams are the annual festivals in temples of central Kerala, especially the "Uthraalikkaavu Pooram" and "Machad Thiruvanikaavu Vela" which are well known for their firework extravaganzas and rituals respectively, during the festivals. The "Pathinettara (eighteen and half) Kavu Vela" is famous which takes place on the first day of Kumbha masam at different temples in and around Wadakkanchery. The most famous fireworks are during the festival at Sree Rudhira Mahakali (shortened to Uthrali) Kavu. This takes place in the month of Kumbham (February–March). The pomp and gaiety of this occasion is matched only by the fireworks of the Thrissur pooram. It falls on the very next Tuesday of the Machad Mamankam during the month of Kumbham. The Para Purappad here is on the same day of Machad Mamankam.

Unlike other temple festivals in Kerala where caparisoned elephants are the main attraction, the 'Machad Mamankam' or 'Machattu Vela' is celebrated on the Tuesday coming after the first Friday of the Malayalam month Kumbha, with huge models of caparisoned horses. Villages in the nearby area of the temple participate in the festival in a competitive but spiritual way. These huge horses are carried by the youth of their respective villages to the temple.

Many important places of worship are in the town. These include Uthraalikkaavu temple, Machad thiruvaanikkavu, Akamala Sastha temple and Maari Amman Kovil, St. Francis Xaviers Forane Church, St. George Malankara Orthodox Syrian Church, India Pentecostal Church of God, Assemblies of God Church, Ottupara Town Masjid, and Juma Masjid. The Dhanwanthari Temple at Nelluvay near Erumapetty (on Wadakkanchery–Kunnamkulam Road, approximately 8 km from Wadakkanchery) is another place of religious interest. The Siva temple at this place is considered an archaeological monument by the Archaeological Survey of India. The Pallimanna Siva Temple at Kumblangad at 3 km from Wadakkanchery is another archaeological monument by the Archaeological Survey of India, famous for the wall paintings in the temple. The St. Jude Thaddeus Church is located at Kumbalangadu, 3 km away from Wadakkanchery. The Carmalmatha church is another famous church nearby, located at Kundannur, 5 km away from Wadakkanchery. Hospitals in the town are Wadakkanchery district

hospital, Divine Hospital and Holly medical centre nearby Ottupara–Vazhani road. A part of Thrissur Medical College and its premises in the Wadakkanchery Municipality. Wadakkanchery assembly constituency is part of Alathur Lok Sabha constituency.

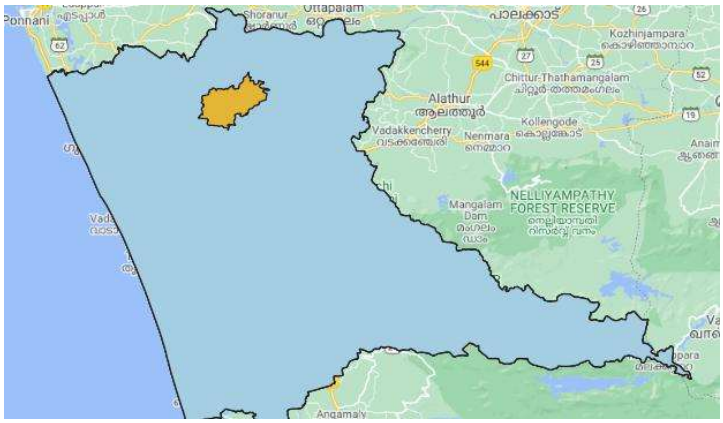


Fig.2 Wadakkanchery Municipality located in Thrissur District Map

- **Important Landmarks**
- Uthraalikkaavu Temple, Wadakkanchery
- Nelluvai Dhanwathari Temple, Nelluvai
- Machad Tiruvaanikkavu Temple, Thekkumkara
- Akamala Temple, Wadakkanchery
- Kerala Kalamandalam Cheruthuruthy
- Kozhimamparambu temple, Cheruthuruthy
- Kulasekharanellur siva Temple, Cheruthuruthy
- Vazhani Dam
- Asuramkundu Dam, Attoor, Chelakkara
- Vallathole Musium, Cheruthuruthy
- Bharathapuzha
- Poomala Dam and Cheppara
- Pathirikkotukavu temple.
- Kodassery mala shivaparvathi temple
- Periyammakkavu temple
- Kuttiyankkavu Temple, Minalur
- Cheru chakki chola check dam, Wadakkanchery
- Thoomanam waterfall Wadakkanchery

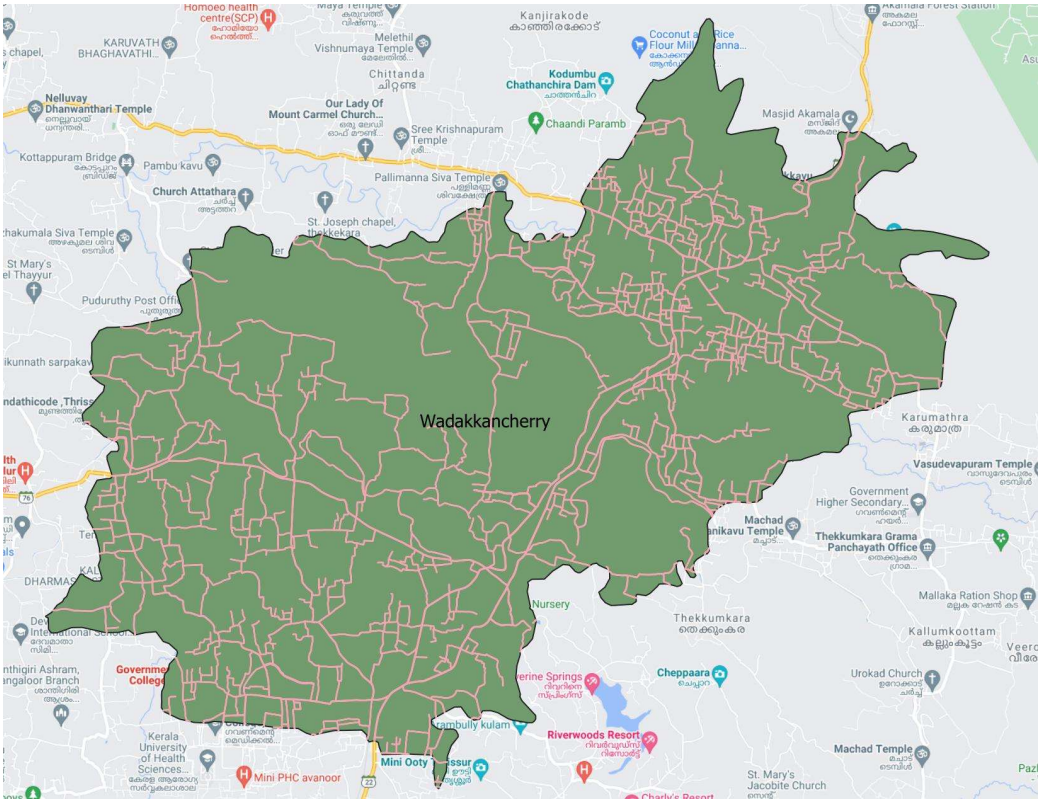


Fig.3 Map of Wadakkanchery Municipality

2.3 PRESENT CONDITION OF SEWAGE COLLECTION AND DISPOSAL

Wadakkanchery Municipality is located about 20 Kilometres to the North of Thrissur Town. As per Honourable NGT report The Aloor- Kecheri River which passes through Wadakkanchery municipality is included under Class-4 Category and the polluted stretch is identified at Challipadam Thodu. At present there is no centralised sewerage system working in the project area. However onsite sanitation facilities available for majority of the portions under the project area. Hence it is imperative that a comprehensive sewerage masterplan for the Wadakkanchery Municipality is inevitable to meet the future demand considering the urbanisation and growth.

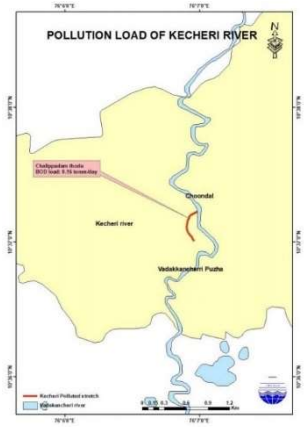


Fig.4 Polluted strech in Aloor – Kecheri Puzha

2.4 EXPECTED SEWER LOAD FROM PROJECT AREA

For computation of sewage load, population forecast has been performed in the geometrical progression method. For the local body, the decadal population variation has been taken as the mean value of the last decadal variation value for it and for the District. Form this value expected population in 2052 has been determined from the base year of 2011, since the latest Census data is available for the year 2011. For computing the sewage load, return ratio of 80% has been adopted. In addition to this, for the non-domestic and floating demand, a value of 20 percentage is taken and for unaccounted water and infiltration, another 20 percentage is taken. In addition, social survey was also conducted to determine the number of houses, shops etc. and other buildings in the project area.

SI.NO	Description	Number	Expected Sewerage Load in MLD
1	Houses	832	0.4
2	Small Shops	534	0.03
3	2 Floor Complex	264	0.11
4	3 Floor Complex	329	0.18
5	4 Floor Complex	54	0.04
6	Flats	12	0.01
7	Cinema Theatre	2	0.02
8	Govt. Offices	18	0.03
9	Hotel Rooms	60	0.01
10	Restaurants	12	0.01
11	Schools	2	0.03
12	Hospitals	2	0.04
		Total	0.91 MLD

*In addition to the above sewerage load the septage for the remaining area is also calculated.

Table 1 Expected sewer load from project area

2.5 SEWERAGE TECHNOLOGY

Decentralized wastewater management system (DWMS) may be designed as the collection, treatment, and disposal/reuse of sewage from individual houses, cluster of houses, isolated communities, industries or institutional facilities as well as from portion of existing communities at or near the point of generation of sewage. Decentralized systems maintain both the solids and liquid fraction, although the liquid portion and any residual solids can be transported to a centralized point for further treatment and reuse.

Recognizing the many applications and benefits of sewage reuse, some important points may be kept in view such as (i) review of the impact of the population growth rate (ii) review of potential water reuse applications and water quality requirements (iii) review of appropriate technologies for sewage treatment and reuse (iv) considering the type of management structure that will be required in the future and (v) identification of issues that must be solved to bring about water reuse for sustainable development on a broad scale. It has been emphasized that if the sewage from the urban and semi urban areas were reused for a variety of non-potable uses, the demand on the potable water supply would be reduced.

The choice of appropriate technology will also depend on several factors such as composition of sewage, availability of land, availability of funds and expertise. Different operation and maintenance options will have to be considered with respect to sustainable plant operation, the use of local resources, knowledge, and manpower.

2.6 STRATEGY FOR SEWERAGE SYSTEMS

For formulating a strategy for planning, designing and implementing sewerage systems for a project area it is imperative to closely examine the factors contributing to the generation of sewage load and its effective treatment, recycling and disposal arrangements. For this purpose, each location in the project area concerned has been analysed thoroughly using available data on the following parameters and features:

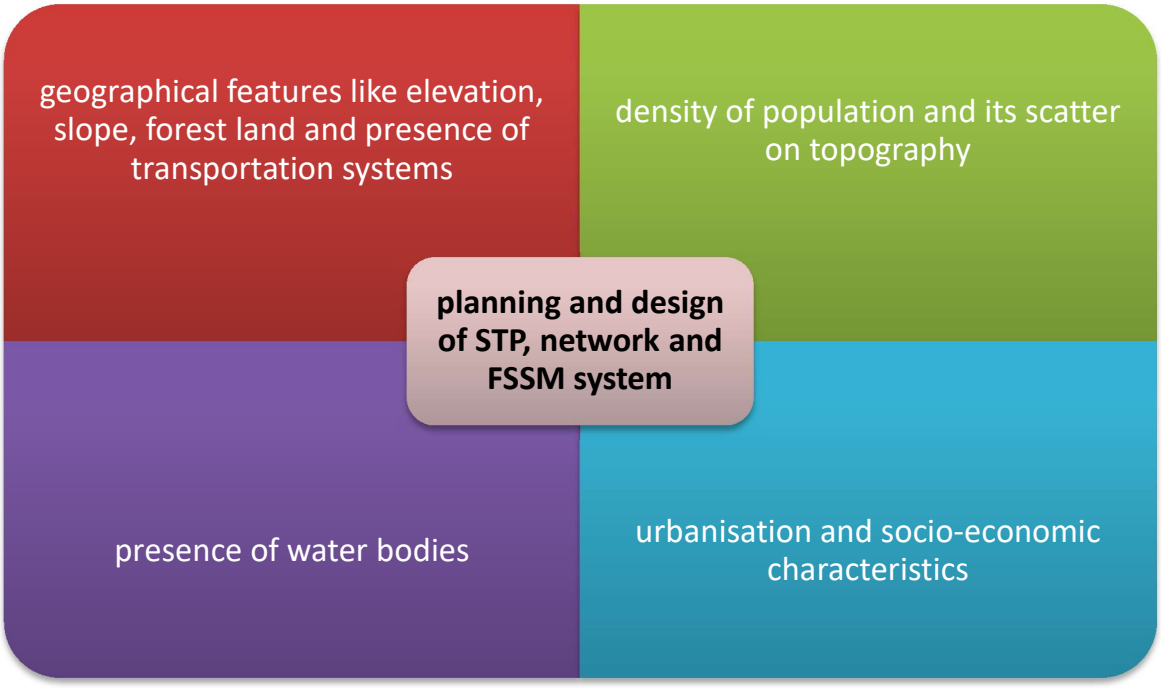


Fig.5 Parameters for analysing LSGI's for sewerage/FSSM system

Since another important feature influencing the sewage load generation and its subsequent management task is the scatter of population density, an analysis was performed in this regard. Population forecast

for the project area was carried out using geometrical progression method with the increment percent as the mean value of last decade increment and the district average value.

2.7 PLAN FOR AREAS DIRECTLY CONNECTED TO POLLUTION OF WATER BODIES

The management of onsite sanitation systems such as septic tanks remains a neglected component of urban sanitation and wastewater management. Sullage, which is a fluid mixture of untreated and partially treated sewage solids, liquids and sludge of human or domestic origin, flows out of septic tanks and enters waterways or is generally disposed into nearest water body or nearest drain or low-lying areas. Solids accumulating in the septic tank that is defined as septage is periodically taken out and disposed of without treatment. This leads to serious health and environmental implications. In the absence of efficient water treatment systems and solid waste management systems, untreated domestic and industrial wastes, and agriculture-runoff flow into the rivers polluting the rivers in the locality. There has been widespread bacteriological contamination of faecal origin in ground and surface water which relate to proximity of increasing numbers of leach pit latrines, leakages from septic tanks, washing, bathing and other domestic activities. This scenario demands a planned sewerage system for the areas which are in proximity to the rivers.

Sl. No.	LSG	Water body in River Rejuvenation Program as per Order dated 22.06.2020 in the matter of OA No. 673 of 2018	Details of action plan as a part of abatement of pollution
1	Wadakkanchery Municipality	Kechery River Polluted stretch identified (Puliyannor to Kechery).	Polluted stretch identified (Puliyannor to Kechery).

Table 2 Polluted stretch of Kechery River

2.8 PROGRAMME FOR ABATEMENT OF POLLUTION TO ENVIRONMENT

In the river rejuvenation programs several departments of Kerala State Government has been jointly chalked out short term and long-term plans for the abatement of pollution to the rivers. Local Self Government Institutions (LSGI's), Irrigation department, Kerala State Pollution Control Board, Ground Water Department and KWA etc. are among these participants. In the short term plans, identification of polluted stretches, surveillance to restrict dumping of wastes into river and its branches, cleaning and desilting of canals, closing of all unauthorized outlets leading to the river, boards to display slogans against littering waste in various places other activities like posters, notices and awareness classes, river water quality monitoring, inspection and effluent quality monitoring of the flats, industrial units, service stations, hospitals, hotels etc. are envisioned. In the long-term action plan, planning, design and operation of STPs and FSSM units are envisaged. These treatment facilities are to be so designed that safe disposal and recycling of the wastewater can be materialised. If decentralised units are planned, management of operation is observed to be optimised. Ground water recharging / rainwater harvesting

etc. are also to be planned in the long-term action sequence. The strategy for abatement of pollution to environment can be summarised as follows:

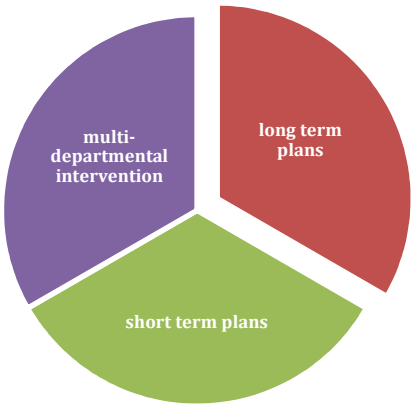


Fig.6 The strategy for abatement of pollution to environment

2.9 OUTLINE OF SEWERAGE IMPLEMENTATION

In the implementation procedure for sewerage schemes, multi-faceted approach is essential to achieve its goals. Since the primary goal of sewerage system is providing hundred complete and scientific sanitation facilities for every household, grass route level planning is necessary. Every local body must be able to prepare a sanitation plan which can be implemented along with the development document for the LSGI.

Since the State is heading for a rapid expansion in drinking water production and distribution sector KWA, especially on materialising a 24 X 7 drinking water concept in urban areas, and to ensure the households have 100% access to piped water supply, mostly through individual connections, the sanitation facilities will generally improve. However, the production of sewage will also increase and hence this will demand sewerage facility for every household unit. Additionally recycling of grey water is also to be planned and implemented for non-drinking water usage.

For effective implementation of the sewerage there should also an Integrated Management Information System (IMIS) which is continuously updated.

2.10 PLAN FOR REUSE OF RECYCLED SEWAGE

In the planning and implementation of water reclamation and reuse, the reclaimed water application will usually govern the wastewater treatment needed to protect public health and the environment, and the degree of reliability required for the treatment processes and operation (Metcalf and Eddy). The major wastewater re use categories are as follows:

a] agricultural irrigation, crop irrigation and commercial nurseries

b] landscape irrigation

c] industrial recycling and reuse

d] groundwater recharge, groundwater replenishment and saltwater intrusion control

e] recreational/environmental uses

f] non-potable urban uses

e] potable reuse

In the present project, the dewatered sludge can be used as a manure for cultivating vegetables and other plant life.

2.11 INTEGRATION WITH OTHER PROJECTS

Planning and design of sewerage schemes can be combined with other water resources projects also. This is since most of these projects are inter-related and environment sensitive. Hence the location of an STP, collection wells and coverage of sewage networks in an area depends upon the water supply system existing in that area, proximity of irrigation canals, water bodies and flood routing structures if any. The integration of different projects related to the water resources and conservation schemes greatly influence the successful establishment and operation of the sewerage schemes in an area. As shown below and integrated planning of the projects associated with water resources will contribute effectively for a successful sewerage system.

CHAPTER 3

PLANNING, DESIGNING AND LAYING OF SEWAGE NETWORK

3.1 GENERAL

The most common type of sewer construction practice involves the use of open trenches and prefabricated pipes. In the present project also, open trenches are planned in most of the areas for laying of sewer load carrying pipe network. Sewer loads generated from individual households, commercial establishments, public institutions etc. in the core area of the Wadakkanchery town is collected from the source nodes and carried through pipes and concrete chambers to the nearest manholes. From there it is transported through a network of pipes towards the Sewage Treatment Plant (STP). Care has been taken to limit the depth of cutting below 4 meters in most of the cases to avoid construction and operation difficulties. For septage management, de-sludging from sources are performed annually using special equipment and septage is carried to the STP for co-treatment after desirable dilution.

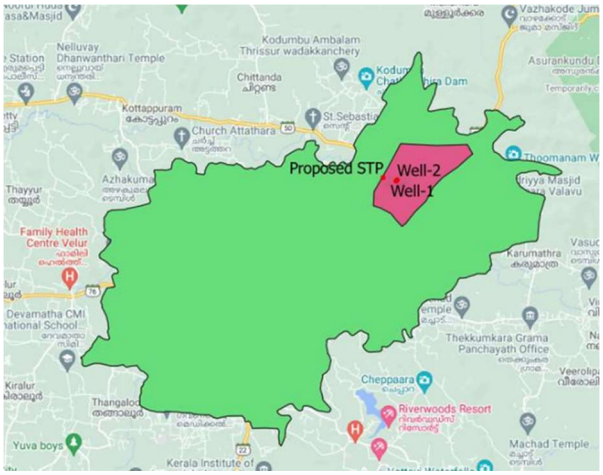


Fig.7 Sewerage and Septage zones in Wadakkanchery Municipality

In Wadakkanchery municipality the densest area is in Wadakkanchery town and in the nearby area. As per the discussion done with municipal authorities it is decided to propose a sewage network system in the main town area and to propose septage for the remaining area as most of areas in Wadakkanchery municipality still have rural nature. Co-treatment facility is also provided here to treat the septage waste in the same STP.

In the Sewerage zone it is proposed to lay sewers for about 14 Kilometres with pipe size ranging from 225 mm to 355mm outer diameter. Manholes are proposed at every 30 m interval and in every bends and road junctions. Two wells are proposed on two sides of Aloor- Kecheri river and from there pumping of sewerage to the STP site which is about 900 meters from the Wells. As the Municipality doesn't own land here, private land which are suitable is proposed for well and STP.

3.2 COMPONENTS OF SEWAGE NETWORK

The components of the sewage collection and carriage network consists of the following elements:

Sl. No.	Type of element	Material	Function
1		Reinforced concrete	Collection of sewage from individual units for transferring to manholes
2	Sewer pipelines	High Density Polyethylene (HDPE)	Transfer of sewage by gravity flow from one point to other
3	Manholes	Reinforced concrete	Sewage collection points and inspection areas for removing blocks and cleaning of lines
4	Lift manholes	Reinforced concrete	Sewage collection points and inspection areas for removing blocks and cleaning of lines and lifting of sewer load to the next manhole. Submersible pump sets are installed inside in such manholes.
5	Collection well	Reinforced concrete	Centralised collection point for sewer load from a sub-zone in the project area.
6	Pumping station	Reinforced concrete	Centralised collection point for sewer load from a sub-zone in the project area and pumping of sewage to the next well or STP.

Table 3 Components of sewage network

3.3 DESIGN OF SEWAGE NETWORK

For the design of sewage network, hydraulic analysis was performed for the initially planned network and refined for a set of constraints and inflow values. The pipelines are designed for gravity flow conditions except for lifting and collection points. Minimum outer diameter of the pipeline was taken as 225 mm for main lines along the roads and for carriage from chambers to manholes, it is taken as 180 mm with material as HDPE. The slope was taken as a minimum value of 1 in 170 in general and care has been taken to provide sufficient slopes to generate self-cleansing velocities during peak flow conditions when the pipe is near to full in load. All stipulations given by the relevant Indian Standard Codes of practice and CPHEEO Manual has been adopted in design.

3.3.1. CREATING PRIMARY MODEL FROM GEOGRAPHIC INFORMATION SYSTEMS (GIS)

Using GIS data available, the project area was examined thoroughly, and a primary model of sewer flow was generated. This model was later refined using reduced elevations obtained from Differential Global Positioning System (DGPS) Real Time Kinematic Survey (RTK) values at the control points established in the primary model. The GIS provides information of population density scatter, presence of water bodies, road network and topographical features as a quick reference for planning an optimum site for the STP as well as the routing of sewer load.

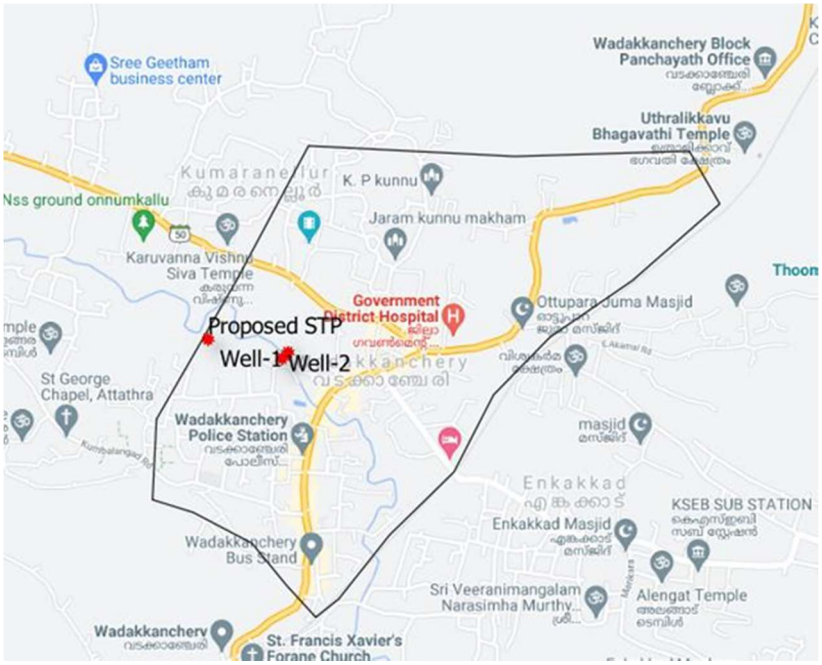


Fig.8 Wadakkanchery Sewage Network Zone in Google Map Backdrop

Fig.9 Satellite imaginary of proposed collection wells and STP

3.3.2 TOPOGRAPHICAL SURVEY USING DGPS

For ascertaining accurate reduced levels of all control points in the primary model, Real Time Kinematic Survey (RTK) using DGPS was performed. DGPS is an improved autonomous Global Positioning which reduces the effect of correlated errors from two or more receivers only if they are all observing the same satellites. The DGPS data was retrieved in a computer system and subsequently used for hydraulic simulation of the network.

Fig. 10 Base station setting for DGPS survey at Wadakkanchery Municipality

3.3.3 SOCIAL SURVEY

Social aspects of the sewage load generation have been examined in detail by performing social survey for the project area. Various teams comprising of people intended to gather information regarding presence of houses, commercial establishments and other public institutions were set up and extensive field survey was conducted. The variations of sewage flow and expected abnormalities were also studied and incorporated in the sewer network design. Expected sewer load in the core area is shown as follows:

SI. No.	Description	Number	Expected Sewerage Load in MLD
1	Houses	832	0.4
2	Small Shops	534	0.03
3	2 Floor Complex	264	0.11
4	3 Floor Complex	329	0.18
5	4 Floor Complex	54	0.04
6	Flats	12	0.01
7	Cinema Theatre	2	0.02
8	Govt. Offices	18	0.03
9	Hotel Rooms	60	0.01
10	Restaurants	12	0.01
11	Schools	2	0.03
12	Hospitals	2	0.04
		Total	**0.91 MLD**

Table 4 Social survey details

3.3.4 HYDRAULIC SIMULATION OF SEWAGE NETWORK

Hydraulic simulation of sewage network was performed after collection of all basic input data like sewage inflow at all points, expected routing plan for easy carriage of sewer load towards a common collection point and location of STP. A suitable peak factor to accommodate sewage flow variations are provided in the hydraulic analysis. The sewer flow is expected to be carried out in gravity conditions through a network of pipelines, manholes and lifting stations. The maximum depth of cutting is limited below 4.0 m and hence sewage lifting stations are provided making use of the manholes itself. For all pipelines minimum slopes to generate gravity flow is given as per the recommendations of CPHEEO Manual of Sewage Treatment Systems.

For hydraulic simulation of the sewage network comprising of pipelines, manholes and lifting stations, US Environmental Protection Agencies' Storm Water Management Model (SWMM) is adopted considering its versatility in hydraulic modelling using dynamic flow routing conditions. US EPA's Storm Water Management Model (SWMM) is used throughout the world for planning, analysis, and design related to stormwater runoff, combined and sanitary sewers, and other drainage systems.

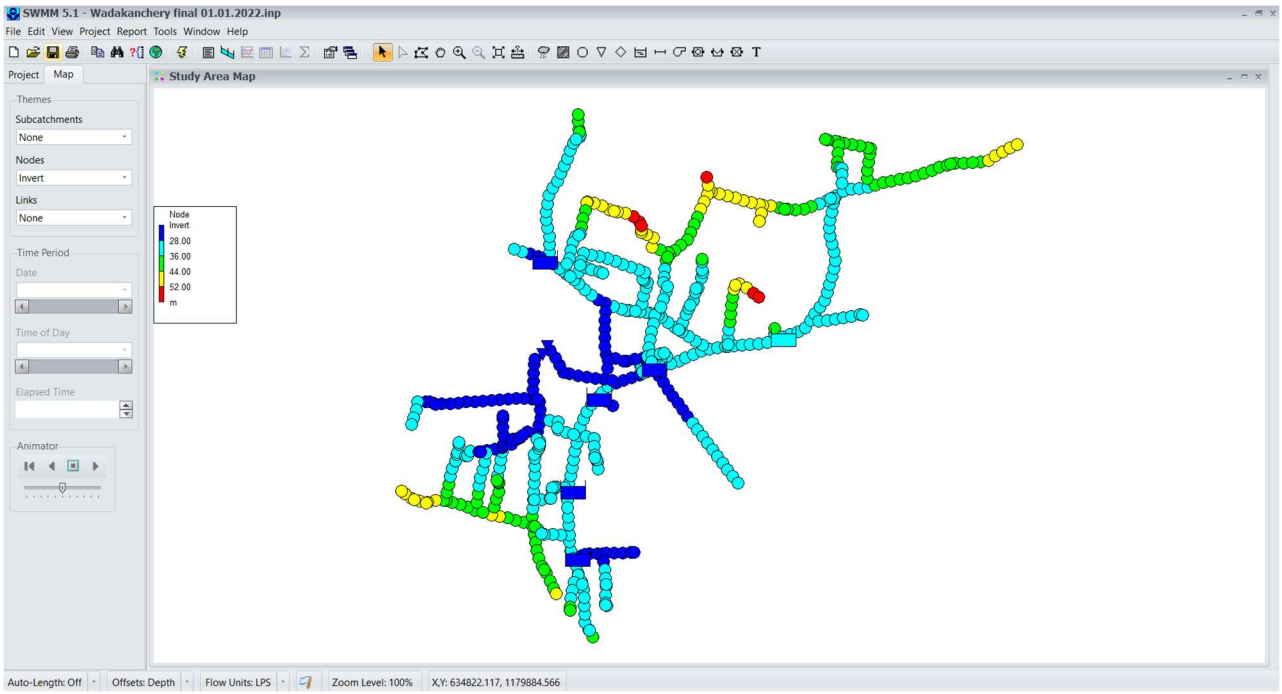


Fig.11 Map area in SWMM model with invert levels of nodes in gradation

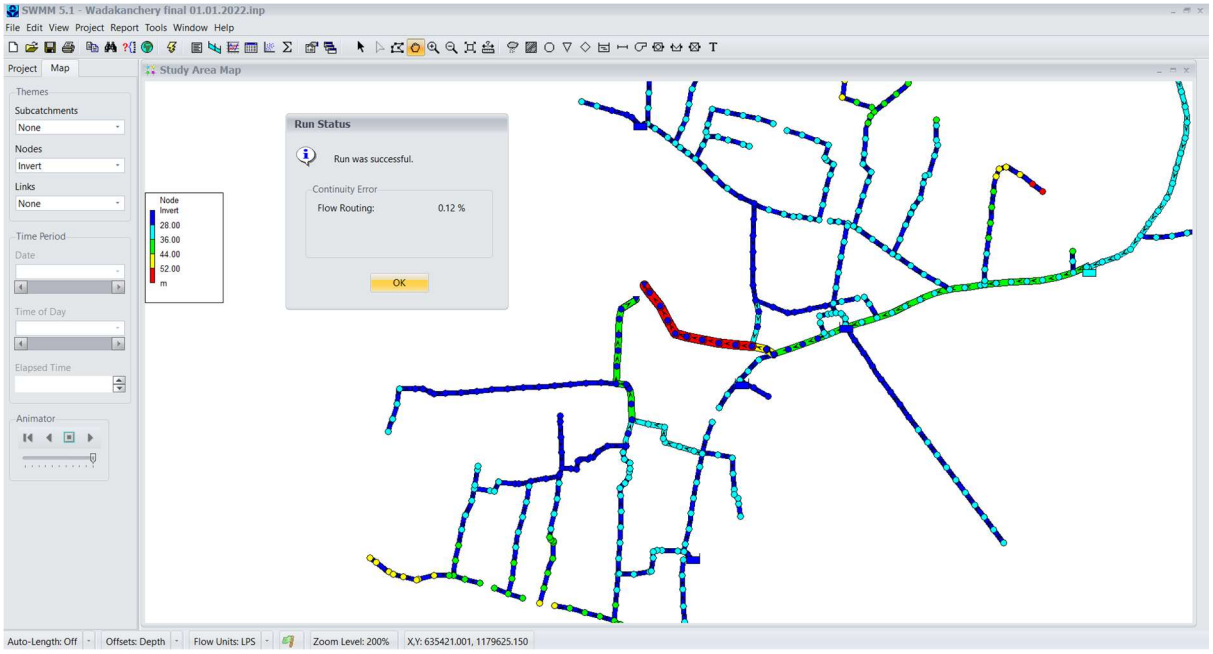


Fig.12 Map area in SWMM model with flow routing in gradation towards outfalls

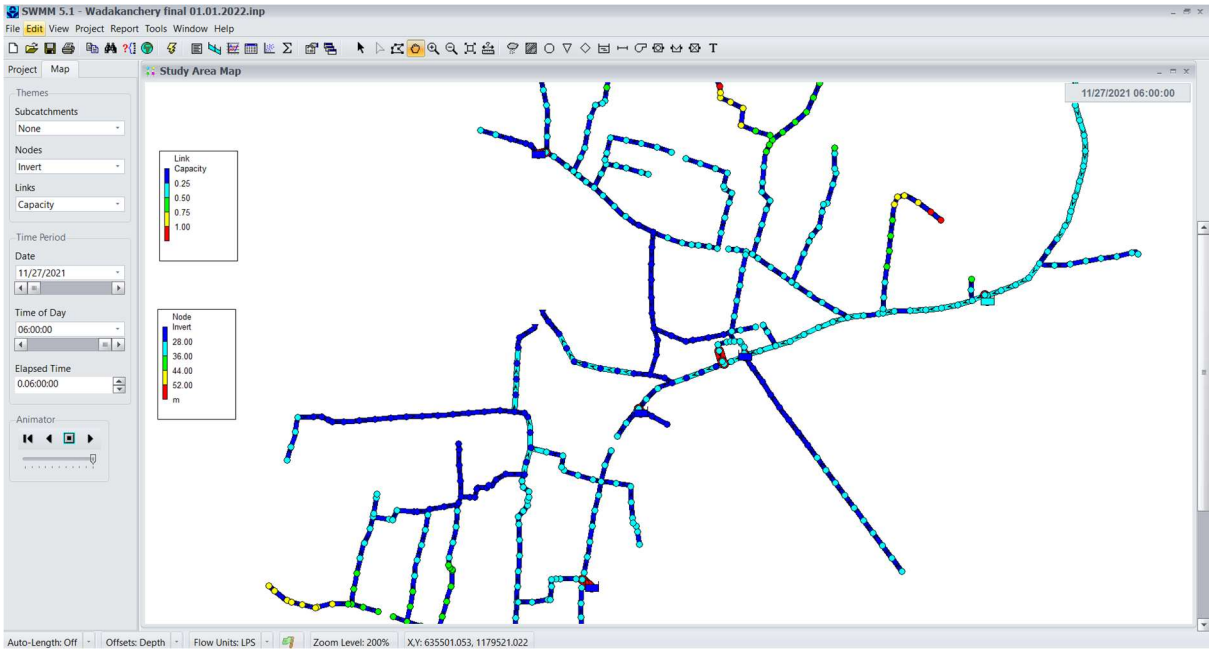


Fig.13 Map area in SWMM with capacities of pipelines during peak flow in gradation

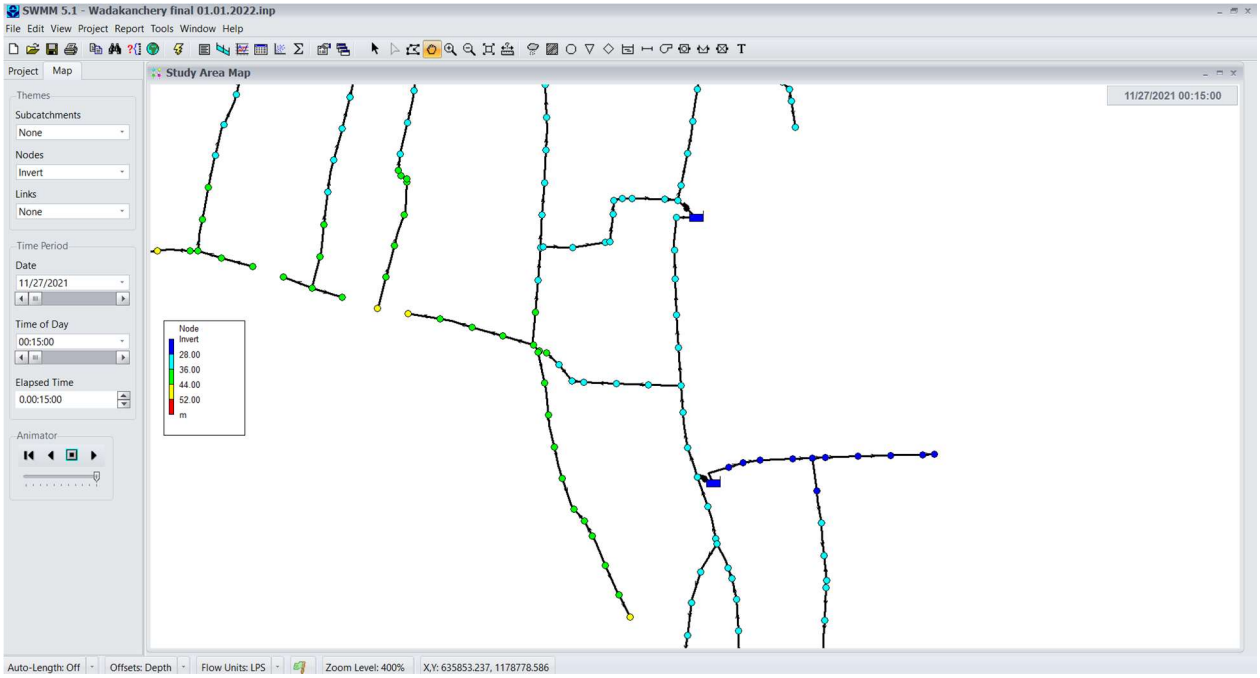


Fig.14 Map area in SWMM model with lifting stations and pumps

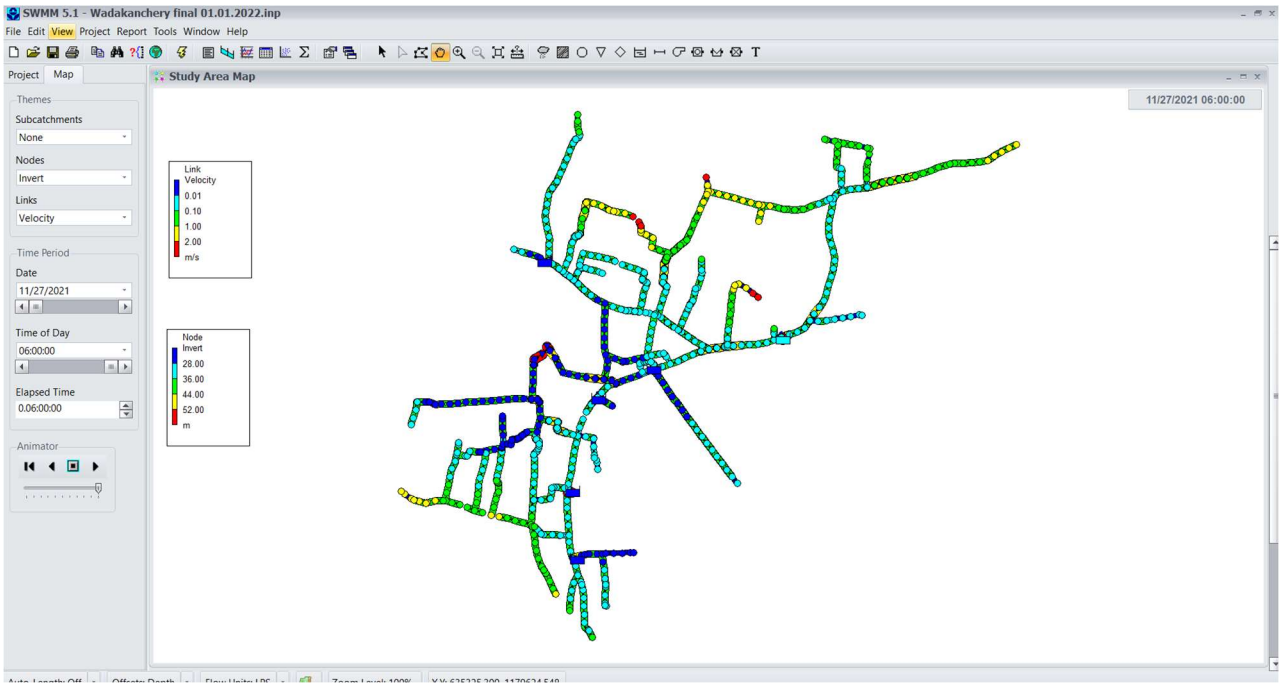


Fig.15 Map area in SWMM model with velocity profile in gradation

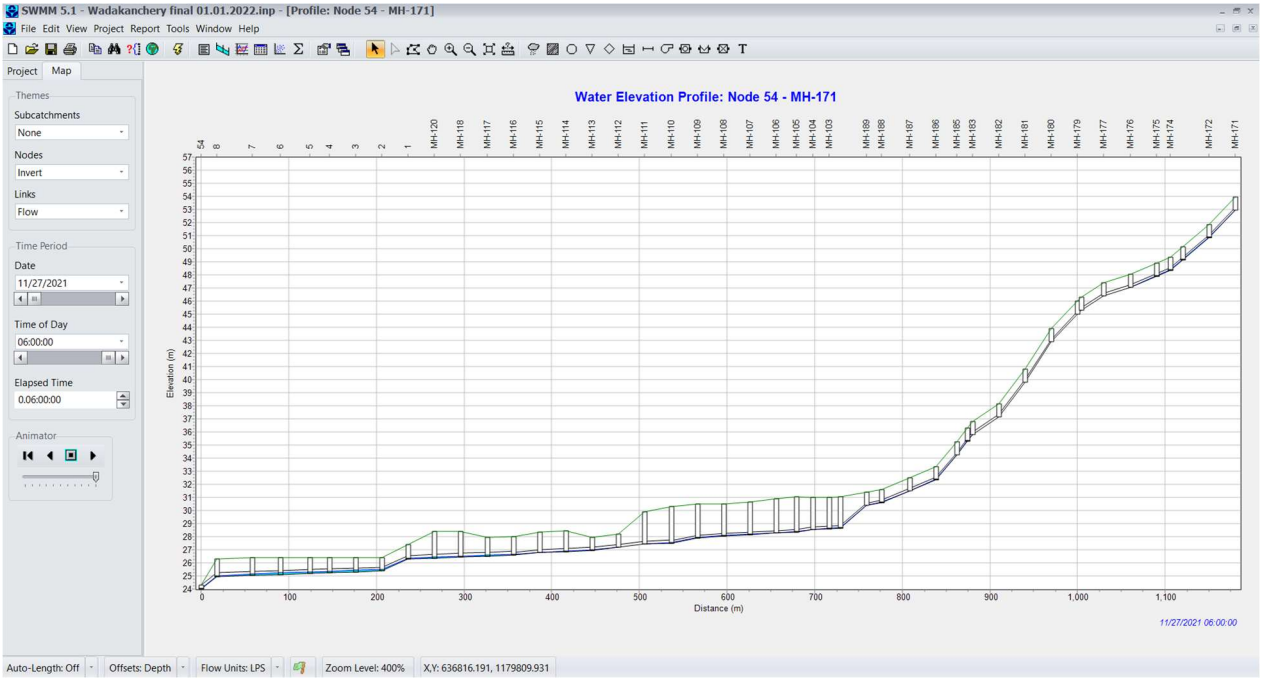


Fig.16 Water elevation profile plotted in SWMM model of sewage network

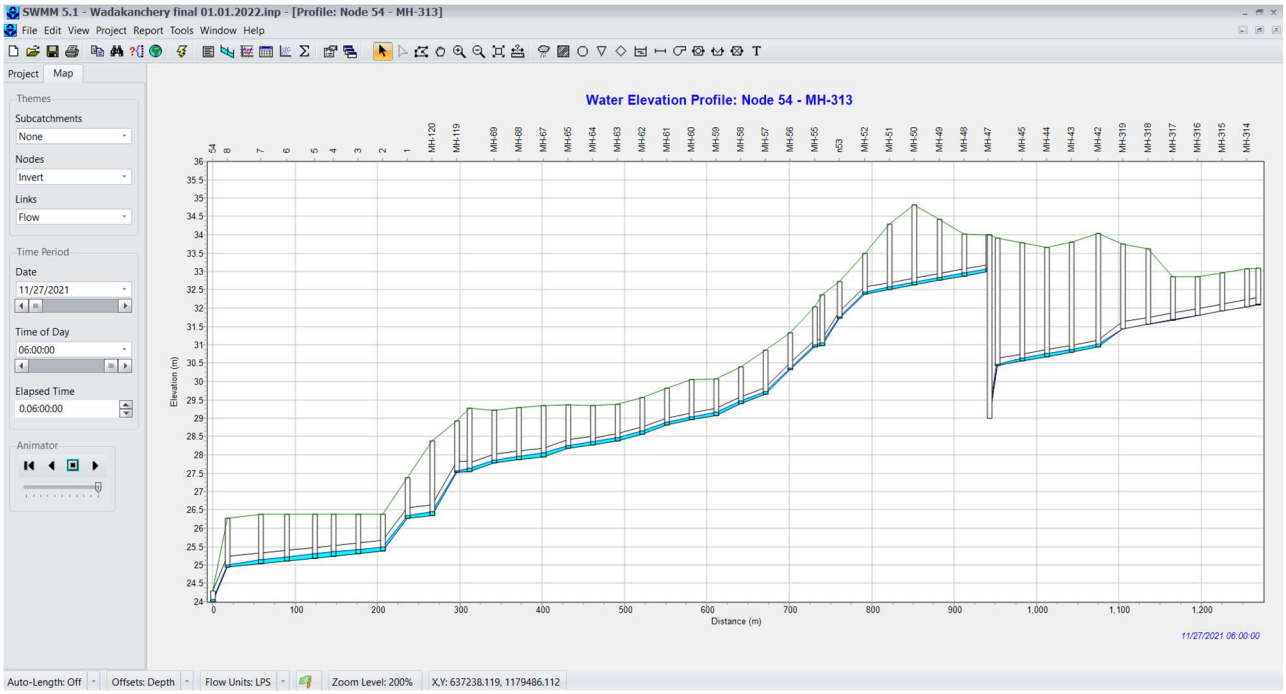


Fig.17 Water elevation profile plotted in SWMM model of sewage network with lifting in between

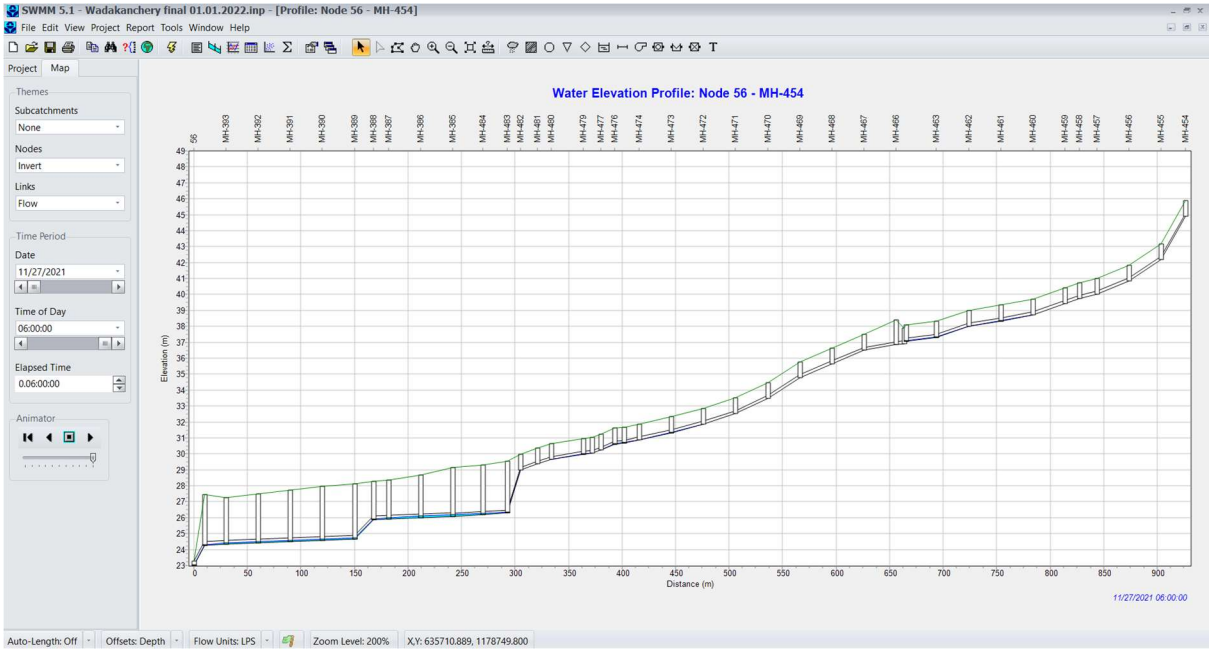


Fig.18 Water elevation profile plotted in SWMM model of sewage network

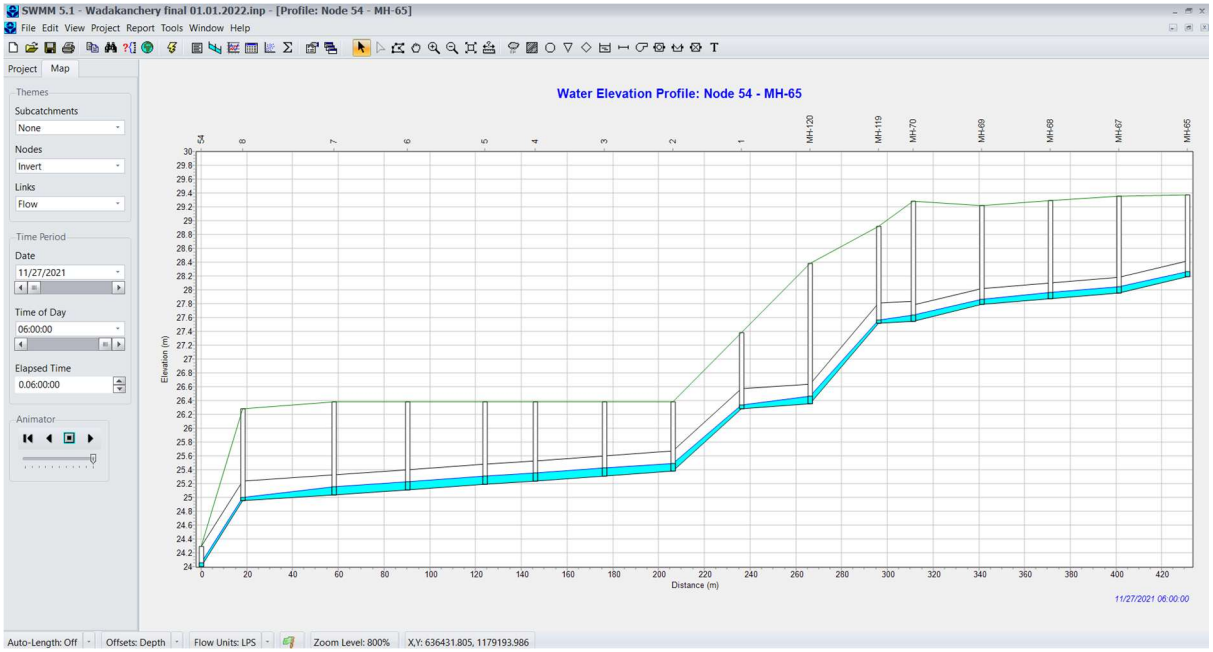


Fig.19 Water elevation profile plotted in SWMM model of sewage network for a small reach

Sl. No.	Type of pipe	Internal diameter (mm)	Outer diameter (mm)	Pressure rating	Total length (m)
1	High density polyethylene (HDPE)	135.55	180	PN 8	6756.00
2		169.50	225	PN 8	12668.40
3		211.05	280	PN 8	578.30
4		267.60	355	PN 8	421.00

Table 5 Pipes proposed for sewage network-gravity flow

Sl. No.	Type of pipe	Internal diameter (mm)	Outer diameter (mm)	Pressure rating	Total length (m)
1	High density polyethylene (HDPE)	169.50	225	PN 10	230
2		211.05	280	PN 10	900

Table 6 Pipes proposed for sewage network-pressurised flow

3.4 DESIGN OF MANHOLES AND LIFTING STATIONS

A manhole is an opening by which a man may enter a sewer for inspection, cleaning and other maintenance and fitted with a removable cover to withstand traffic loads in sewers. Having designed the sewer system, the manholes are first constructed in identified reaches before the sewers are laid. The diameters of circular manholes for stated depths of sewers are in Table as shown below:

Sl. No.	Range of depths, in m	Internal diameter in m
1	Above 0.90 m and up to 1.65 m	0.90
2	Above 1.65 m and up to 2.30 m	1.20
3	Above 2.30 m and up to 4.5 m	1.50

Table 7 Details of manholes

Manholes are primarily designed as reinforced cement concrete manholes with special treatment to resist corrosive and adverse environments. Manholes should be built to cause minimum head loss and interference with the hydraulics of the sewer line. One way to maintain a relatively smooth flow transition through the manhole, when a small sewer joins one of a larger diameter, is to match the pipe crown elevations at the manhole. Precast rings for shaft can be done to manage inlet and out portions and house sewer connections through chambers. The structural design of the manholes is performed to withstand traffic loads also with controlled cracking under severe exposure conditions.

Sl. No.	Type of manhole	Internal diameter (m)	External diameter (m)	Average depth (m)	Average volume (m^3)	Total number	% of total number
1	Class – 1	0.90	1.40	1.06	0.96	459	81.53
2	Class – 2	1.20	1.80	1.95	2.76	43	7.64
3	Class – 3	1.50	2.20	2.93	5.97	61	10.83

Table 8 Classification of manholes

Situations restricting depth of cutting can be easily got over by restricting the depth of sewers to a practicable limit and diverting the flow into a pavement submersible pump station with a lockable control panel there itself like the pillar boxes of the electricity board and the delivery main can lift the flow to the downstream manhole at the conventional 0.9 m depth to invert. There are called lifting manholes and during the analysis stage itself the number of such manholes are designed to be minimum.

These submersible pump stations of lifting manholes can be operated by mercury float switches and powered by dedicated feeder lines from the local electrical authority like the lines given to the hospitals, etc. These pump sets can also be connected to solar panels. The pump pit can be covered with pedestrian grade walkway slabs which are of reinforced cement concrete and with adequate lifting arrangements to permit the lowering and lifting the submersible pump sets. With the advancement in technology, the IoT enabled sensors can be installed in these lift manholes and connected to a remote-control station using cloud data transfer.

The details of lift manholes are outline below:

Sl. No.	Description of lift manholes	Discharge in LPS	Head in m	Power in HP
1	LF-1	0.69	6	0.10 HP
2	LF-2	3.05	6	0.30 HP
3	LF-3	0.20	6	0.10 HP
4	LF-4	0.40	6	0.10 HP
5	LF-5	7.98	6	0.90 HP
6	LF-6	0.06	6	0.10 HP

Table 9 Details of lifting stations

3.5 DESIGN OF COLLECTION WELLS

There are two collection wells as per the design for the project area. The details of the collection wells are outlined as follows:

Sl.No.	Description	Peak flow in LPS from network	Average flow in LPS from network
1	Collection well-1	10.37	4.15
2	Collection well-2	18.44	7.18

Table 10 Details of collection wells

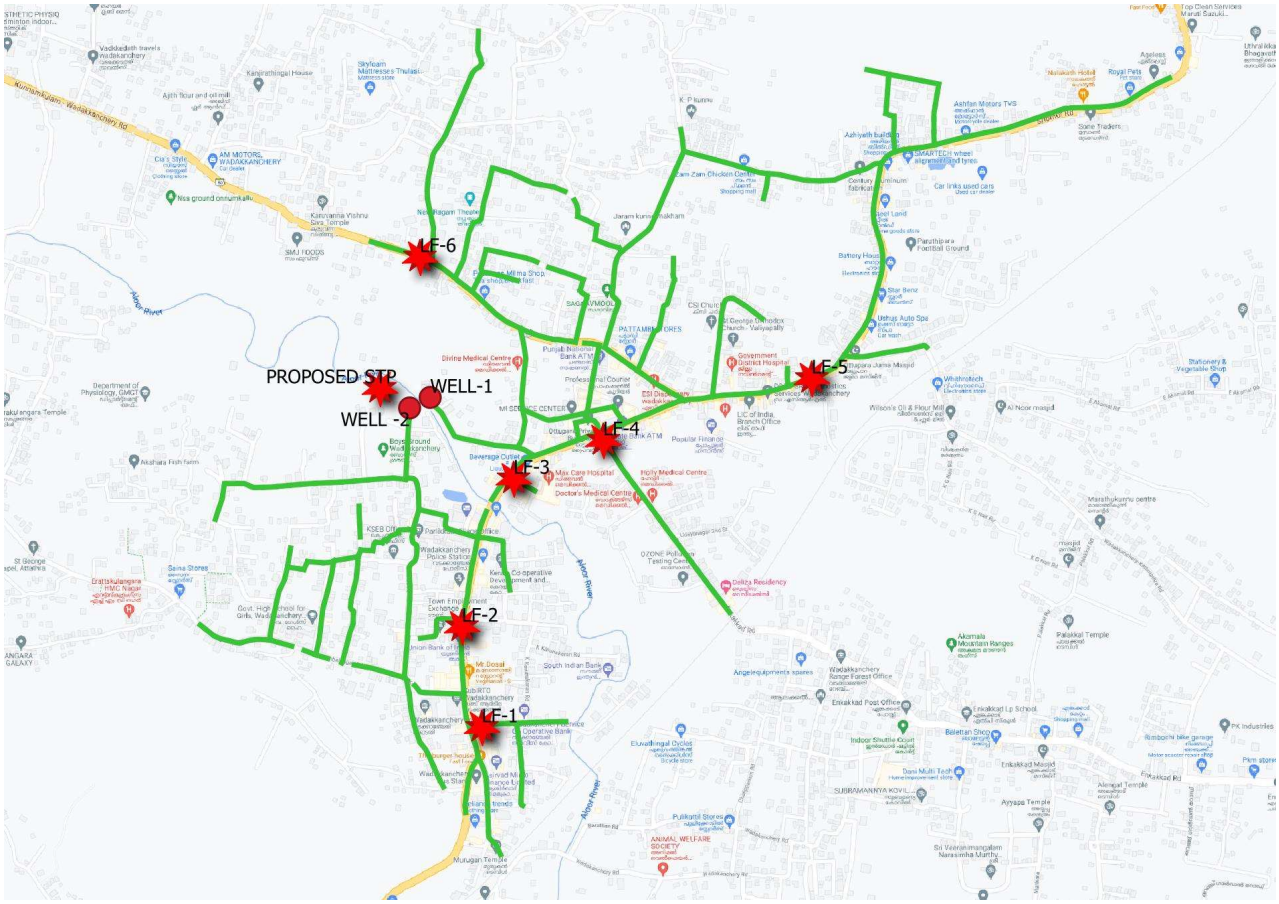


Fig.20 Sewerage zones with lifting station, collection wells and proposed STP

Fig.21 Proposed site for Well 1 & Well 2 on sides of Aloor- Kecheri river

It is planned to collect sewage flow from well-2 to well-1 and sewage load is transported from well-1 to the STP. Each collection well is designed to have adequate storage during peak hours of flow. Two submersible centrifugal pumps are provided to work in parallel during peak hours flow or whenever the situation demands for it. The detailed design of the collection wells is presented below:

DESIGN OF COLLECTION WELL No.2				
Average inflow into well from network	7.38	LPS		
Peak inflow into well from network	18.44	LPS	PF	2.50
Average flow into well from other well	0	LPS		
Peak flow into well from other well	0	LPS		
Total average inflow into well from network+other well	7.38	LPS		
Total peak inflow into well from network+other well	18.44	LPS		
Peak hours	4			
Number of pumps operated in peak hours	2			
Rated outflow during peak hours/pump in parallel	7.38	LPS		
Total rated outflow in peak hours	14.76	LPS		
Inflow converted into storage during peak hours	3.68	LPS		
Volume of sewage to be stored in well	52.99	m^3		
Diameter of collection well-inner	5.1	m		
Depth of collection well for storage	2.6	m		
Volume of sewage stored in well	53.11	m^3	ok	
Wall thickness of collection well	0.45	m		
Base slab thickness	0.45	m		
Offset to base slab	0.45	m		
Outer dia of collection well	6	m		
Freeboard of collection well	0.5	m		
Distance of travel in pumping to next station	50	m		
Velocity of travel adopted	0.9	m/sec		
Diameter of pumping line required	102.18	mm	fix OD	180
		pressure rating		PN 10
Total head for the pump set	12	m		
Discharge for the pump set	7.38	LPS	efficiency	0.5
Power required for pump set/number	2.36	HP	fix HP	2.5
DESIGN OF COLLECTION WELL No.1				
Average inflow into well from network	4.15	LPS		
Peak inflow into well from network	10.37	LPS	PF	2.50
Average flow into well from other well	7.38	LPS		
Peak flow into well from other well	14.76	LPS		
Total average inflow into well from network+other well	11.53	LPS		
Total peak inflow into well from network+other well	25.13	LPS		
Peak hours	4			
Number of pumps operated in peak hours	2			
Rated outflow during peak hours/pump in parallel	11.53	LPS		
Total rated outflow in peak hours	23.06	LPS		
Inflow converted into storage during peak hours	2.07	LPS		
Volume of sewage to be stored in well	29.81	m^3		
Diameter of collection well-inner	5.1	m		
Depth of collection well for storage	2.6	m		

Volume of sewage stored in well	53.11	m^3	ok	
Wall thickness of collection well	0.45	m		
Base slab thickness	0.45	m		
Offset to base slab	0.45	m		
Outer dia of collection well	6	m		
Freeboard of collection well	0.5	m		
Distance of travel in pumping to next station	900	m		
Velocity of travel adopted	0.9	m/sec		
Diameter of pumping line required	127.72	mm	fix OD	225
		pressure rating		PN 10
Total head for the pump set	18	m		
Discharge for the pump set	11.53	LPS	efficiency	0.5
Power required for pump set/number	5.53	HP	fix HP	6

Table 11 Design of collection wells

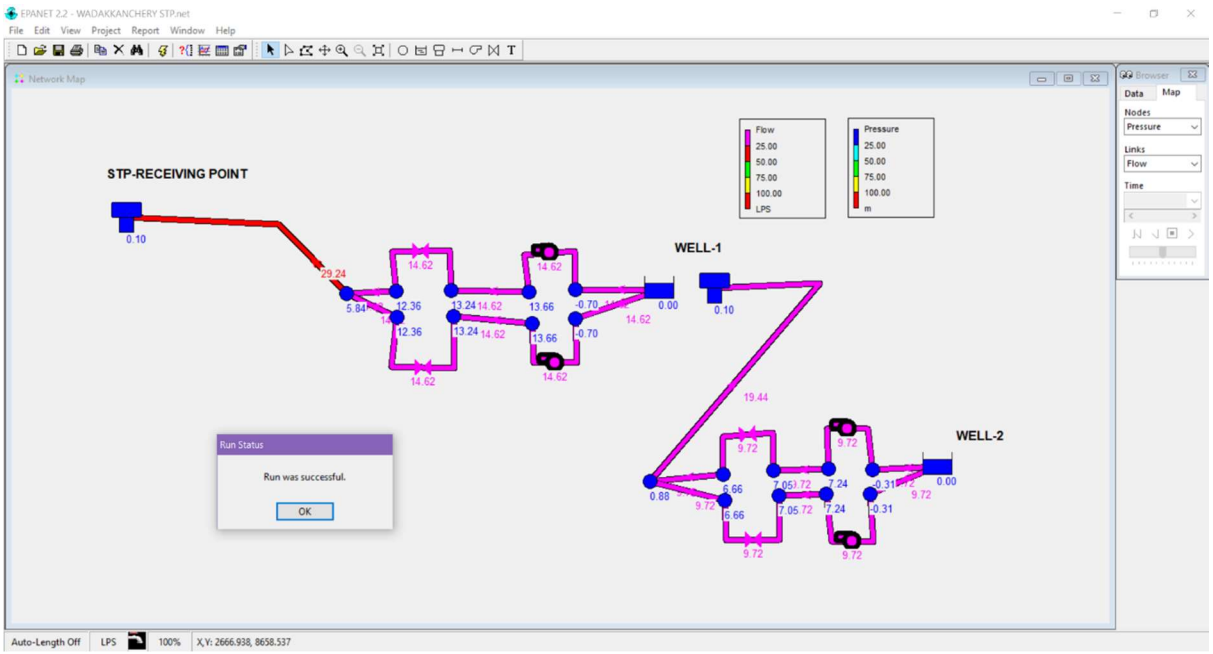


Fig.22 Computer simulation using EPANET for pumping from collection wells

3.6 LAYING OF SEWER NETWORK

In the following sections, important matters in connection with the laying of sewer network and making the system efficient is illustrated in detail.

3.6.1 EXCAVATION AND LAYING

1. On all excavation work, safety precautions for the protection of life and property are essential; and measures to avoid too great inconveniences to the public are desirable. Such measures and precautions include the erection and maintenance of signs (to forewarn public), barricades, bridges and detours; placing and maintenance of lights both for illumination and as danger

signals; provision of watchmen to exclude unauthorized persons, particularly children from trespassing on the work.

2. Computation of the safe load carrying capacity of the pipe when installed and bedded in the manner to be specified using a suitable factor of safety and making certain the design supporting strength thus obtained is greater than the maximum load to be applied.
3. Sewers may be laid in trenches or under embankment in areas which may be temporarily or permanently submerged in water. The fill load in such cases will be reduced and will correspond to the buoyant weight of the fill material. However, effect of submergence could be ignored which provides an additional factor of safety, but it may be necessary to check whether a pipe is subject to flotation. Under submergence, the minimum height of the fill material that will be required to prevent flotation ignoring the frictional forces in the fill can be determined. Wherever sufficient height of fill material is not available, anti-flotation blocks should be provided.
4. All rigid pipes may be tested for strength in the laboratory by the three-edge bearing test (ultimate load).
5. Width of the trench specified for a particular job should be minimum in consonance with the requirements of adequate working space to allow access to all parts and joints of pipe.
6. The Field Engineer should keep in touch with the Design Engineer throughout the duration of the Project and any deviation from the design assumptions due to the exigencies of work, should be immediately investigated and corrective measures taken in time.
7. All pipes used on the work should be tested as per the IS specifications and test certificates of the manufacturers should be furnished for every consignment brought to the site.
8. Whenever shoring is used, the pulling out of planks on completion of work, should be carried out in stages and this should be properly supervised to ensure that the space occupied by the planks is properly backfilled.
9. Proper backfilling methods both as regards to selection of materials, methods of placing and proper compaction should be in general agreement with the design assumptions.
10. In quicksand conditions, it is necessary to anchor the sewer to the ground and hold it at the grade as laid in the face of soil sinkage.
11. The type of bedding (granular, concrete cradle, full concrete encasement etc.) would depend on the soil strata and depth at which sewer is laid.
12. It is understood that the line (horizontal alignment) and grade layout of a sewer line as per design must be carried out meticulously. The horizontal layout determines the location as well as direction of the sewer line, while slope (grade) of the line provides the necessary hydraulic carrying capacity of the sewerage system.
13. The location of the trench is generally laid out first as an offset line running parallel to the proposed sewer centre line. This offset line is demarcated by wooden stakes driven into the ground surface at intervals of, say, 15 m. The offset line, as is clear, is quite away from the sewer centre line with a view not to allow it being disturbed during construction; however, it

must be proximate enough so that the transfer of measurements to the actual trench can readily be done.

14. Two procedures are available to lay pipe sections in the open trench, namely, by batter boards, and by laser beams. Better boards are placed across the trench at uniform intervals. The tops of these boards can be set at some even height above the designed sewer invert elevation. The centre line of the sewer is traced on the boards by extending a line of sight with a transit level or a theodolite and a string is stretched from board to board along this very line. Later on this Line is transferred onto the trench bed by means of a plumb bob. Invert levels and action line is transferred onto the trench bed by means of a plumb bob. Invert levels and characteristics indicated by vertical rods are marked off in even increments -the lower end of each rod is placed on the pipe invert, and the string over the batter boards helps to check if it matches with the proper elevation mark on the rod, by appropriate adjustment of the pipe placement centreline transferred. In the laser method, advantage is taken of an intense, narrow beam of light that is projected by the laser instrument, over a long distance. This beam is aligned through a sewer pipe to strike a target held at the other end of the pipe. A transit that is placed above a manhole helps establish the alignment of the sewer with reference to field survey points and transfer it down to the laser instrument that is mounted inside the manhole. Lasers can achieve an accuracy of 0.01 per cent over up to 300 m
15. Cross drainage works arise when a sewer must cross another service like electricity, water line, gas piping, telecommunication cable, river courses, nalas, etc.
16. Regarding power cables, the sewer shall be above and apart from the power cable by at least 30 cm as per IS: 1255. Regarding water lines, the sewer shall always travel below the water line. Regarding gas lines, the sewer must travel above the gas line so that sewer gases if they escape need not accidentally set off an ignition of the gas line. Regarding telecommunication cables, lateral separation of at least 30 cm shall be followed. In cases of river crossings and nala crossings each situation shall be decided on its site conditions and gravity sewers may be converted to pumped sewer lines by a low lift dedicated pumping station before the crossing discharging into the gravity section after crossing the water course and this will help in always keeping the pumped sewer visible or close to the ground.
17. A cross connection between water main and sewer main seldom occurs because of the sizes of these mains. However, where the location is complicated, the water mains shall be either blue coloured pipes or painted with blue florescent coloured paint.
18. A minimum offset of equal to half the width of the manhole plus 30 cm shall be the lateral offset between water mains and sewer lines. It is advisable to encase the sewer than the water main.
19. Gravity sewers shall not be laid closer to water retaining structures and the effort should be to detour as far as possible. In case of leakages in sewer joints, the leakage may gain access to the sidewalls of the water retaining structures.

20. The width of trench at and below the top of a sewer should be the minimum necessary for its proper installation with the due consideration to its bedding. The width of a sewer trench depends on the type of shoring (single stage or two stage), working space required in the lower part of the trench and the type of ground below the surface.
21. Excavation for sewer trenches for laying sewers shall be in straight lines and to the correct depths and gradients required for the pipes as specified in the drawings. The material excavated from the trench shall not be deposited very close to the trench to prevent the weight of the materials from causing the sides of the trench to slip or fail. The sides of the trench shall, however, be supported by shoring where necessary to ensure proper and speedy excavation. In case, the width of the road or lane where the work of excavation is to be carried out is so narrow as to warrant the stacking of materials near the trench, the same shall be taken away to a place to be decided by the Engineer-in-Charge. This excavated material shall be brought back to the site of work for filling the trench.
22. In case the presence of water is likely to create unstable soil conditions, a well point system shall be employed to drain the immediate area of the sewer trench prior to excavation operation. A well point system consists of a series of perforated pipes driven or jetted into the water bearing strata on either side of a sewer trench and connected with a header pipe leading to a pump, In the event of excavation being made deeper than necessary, the same shall be filled and stabilized.
23. The shoring shall be adequate to prevent caving in of the trench walls of subsidence of areas adjacent to the trench. In narrow trenches of limited depth, a simple form of shoring shall consist of a pair of 40 to 50 mm thick, and 30 cm wide planks set vertically at intervals and firmly strutted. For wider and deeper trenches, a system of wall plates (Wales) and struts of heavy timber section is commonly used. Continuous sheeting shall be provided outside the wall plates to maintain the stability of the trench walls. The number and the size of the wall plates shall be fixed considering the depth of trench and type of soil.
24. In non-cohesive soils combined with considerable ground water, it may be necessary to use continuous interlocking steel sheet piling to prevent excessive soil movements due to ground water percolation. Such sheet piling shall extend at least 1.5 m below the bottom of the trench unless the lower part of the trench is in fine material. In case of deep trenches, if conditions demand, excavation and shoring may be done in stages.
25. All pipes, ducts, cables, mains and other services exposed due to the excavation shall be effectively supported.
26. Trenches for sewer construction shall be dewatered for the placement of concrete and laying of pipe sewer or construction of concrete or brick sewer and kept dewatered until the concrete foundations, pipe joints or brick work or concrete have cured.
27. Where a sewer must be laid in a soft underground stratum or in a reclaimed land, the trench shall be excavated deeper than what is ordinarily required. The trench bottom shall be stabilized

by the addition of coarse gravel or rock. In case of very bad soil the trench bottom shall be filled in with cement concrete of appropriate grade.

28. In the areas subject to subsidence, the pipe sewer should be laid on suitable supports or concrete cradle supported on piles.

3.6.2 SEWER CARRIAGE SYSTEM WITH PIPELINES AND CONNECTIONS TO HOUSES/OTHER UNITS

1. Unlike in the case of CI, DI, UPVC pipe sewers, the HDPE sewers are normally butt welded and pre-assembled on ground and then only laid inside the trench spanning manhole to manhole. The butt welding shall follow the manufacturer's recommendations. Where flanged joints are needed for attaching or inserting fittings and specials like valves, the free end of the HDPE pipe shall be butt welded with a standard flange and thereafter the flanged jointing can be made. However, in the case of such pipes, the uplift during high groundwater conditions above the pipe level is a problem specifically in high ground water and coastal areas.
2. Other than the metallic and concrete pipe sewers, the uplift during high groundwater conditions above the pipe level is a problem specifically in high ground water locations, waterlogged locations and coastal areas. The concrete surrounds or venteak piles shall be used to hold these in place in such conditions, where ground water can rise above the sewer.
3. Each section of sewer shall be tested for water tightness preferably between manholes. To prevent change in alignment and disturbance after the pipes have been laid, it is desirable to backfill the pipes up to the top keeping at least 90 cm length of the pipe open at the joints. However, this may not be feasible in the case of pipes of shorter length, such as stoneware and RCC pipes. With concrete encasement or concrete grade, partial covering of the pipe is not necessary.
4. As soon as a stretch of sewer is laid and tested, a double disc or solid or closed cylinder, 75 mm less in dimension than the internal dimension of the sewer shall be run through the stretch of the sewer to ensure that it is free from any obstruction.
5. Backfilling of the sewer trench is a very important consideration in sewer construction. The method of backfilling to be used varies with the width of the trench, the character of the material excavated, the method of excavation and the degree of compaction required.
6. No trench shall be filled in unless the sewer stretches have been tested and approved for water tightness of joints. However, partial filling may be done keeping the joints open to avoid disturbance.
7. In the design of sewer systems, consideration should be given to the desirability of maintaining velocities sufficient to avoid sulphide build up and of minimizing pressure lines and points of high turbulence. The designer should take into consideration topography, grades of sewers, ventilation, materials of construction, sewage temperature and strength, etc.

8. Any protective coating used should possess the following qualities: (i) it should be resistant to acid attack, (ii) it should bond securely to the concrete, (iii) it should be economical and durable, (iv) it should be resistant to abrasive action by flow of sewage, and (v) when applied, it should be thin enough to fill all pores and irregularities in the surface. The coating should be continuous with no pin holes or other breaks.
9. The house service sewer connections shall be effected only in manholes. In case of old sewers, a new manhole shall be inserted for this purpose. The material of the House Service Sewer shall be either UPVC or HDPE rigid straight pipes of 6 kg/cm^2 pressure class in manufacture and as per IS: 15328 and IS: 4984 respectively.
10. The minimum earth cover above the crown shall be 90 cm and where this becomes impossible, the property owner shall be directed to depress his terminal chamber to comply with the above especially as the public sewer manhole shall start at its crown at 90 cm below ground level. Where such sewers cross the electricity power cables, the specifications of IS: 1255 of 1983 reaffirmed in 2001 in clauses 6.3.3 and 6.3.3.1 shall be followed without any exception that all such house service sewers shall be only above the power cable and the minimum clearance shall be 30 cm over the cable which itself shall be covered all around by 15 cm riddled soil and further protected on top by tiles, bricks or slabs.
11. The house owner shall be mandated to possess a “kraite” a type of non-corroding sufficiently flexible but rigid type of less than 10 mm diameter rod, which he/she shall use to rod the house service sewer freely up to the manhole and the labour of the local body shall not be deployed for any removal of obstructions in the house service sewer. Typically, it is possible to effect six service connections to a manhole.
12. It is also recommended to install collection chambers outside a group of houses and collect sewer load through pipes and connect chamber with manholes using pipes.
13. Sewer network system can be made efficient in operation using huge volume data obtained from individual sensors installed in the manholes and lifting points. This historical data will provide backbone for emergency routing plans for failure of a link or obstructions.
14. Sewer network system must be carefully examined using digital data for potential nodes of weakness or redundancies and specially addressed periodically.
15. There must be continuous coordination between the designer of the sewer network and the engineer in charge of the operation and maintenance of sewer system for addressing issues during repair, expansion of network and diagnostics of blocks.
16. A computer simulation model of the sewer network system must be constantly upgraded with data obtained from sensors for real time monitoring and future predictions of the versatility of the sewer carriage system. Similarly, all lifting manholes must also be continuously monitored in digital platform for performance appraisal and future modifications.

CHAPTER 4

DESIGN OF UNIT OPERATIONS AND SEWAGE TREATMENT PROCESS

4.1 GENERAL

The constituents of concern found in wastewater are removed by physical, chemical, and biological methods. The individual methods usually are classified as physical unit operations, chemical unit processes, and biological unit processes. Treatment methods in which the application of physical forces predominate are known as physical unit operations. Examples of physical unit operations include screening, mixing, sedimentation, gas transfer, filtration and adsorption. Treatment methods in which the removal or conversion of constituents is brought about by the addition of chemicals or other chemical reactions are known as chemical unit processes. Examples of chemical unit processes include disinfection, oxidation and precipitation. Treatment methods in which the removal of constituents is brought about by biological activity are known as biological unit processes. Biological treatment is used primarily to remove the biodegradable organic constituents and nutrients in wastewater (Metcalf& Eddy, Inc).

From practical observations, the rates at which physical, chemical and biological reactions and conversions occur are important, as they will affect the size of the treatment facilities that must be provided. The rate at which reactions and conversions occur, and the degree of their completion, is generally a function of the constituents involved, the temperature, and the type of reactor. The fundamental basis for the analysis of the physical, chemical and biological unit operations and processes used for wastewater treatment is the material mass balance principle in which an accounting of the mass is made before and after reactions and conversions have taken place (Metcalf & Eddy).

In the following sections, the design of unit operations and chemical and biological unit processes are described. The sizes of the units and control parameters are determined.

4.2 COMPONENTS OF SEWAGE TREATMENT SYSTEM

The components of the sewerage treatment system are described in the process flow chart separately attached. The components are listed as follows:

Sl. No.	Description unit	Nature of treatment
1	Receiving chambers	Receive sewage and septage separately
2	Oil and grease trap	Removes oil and scum from sewage and diluted septage
3	Coarse screen channel	Removes impurities of size greater than 20 mm by physical separation using screens
4	Fine screen channel	Removes impurities of size greater than 6 mm by physical separation using screens
5	Grit separator	Removes impurities of size greater than 0.15 mm by gravity settling
6	Flow channels	Gravity sewage flow open channels

7	Equalisation tank	Normalises flow by storing during peak hours and releasing during off peak hours
8	MBBR-1	Biological reactor with suspended and attached growth process for BOD removal from sewage
9	MBBR-2	Biological reactor for nitrification process
10	MBBR-3	Biological reactor for de-nitrification process in post anoxic condition
11	MBBR-4	Biological reactor for final stage of BOD removal after de-nitrification
12	Secondary clarifier with plate settler	Clarification of biologically treated water using sludge blanket and plate settler.
13	Chloring contact tank	Disinfection of clarified water
14	Filter feed tank	This is used for holding clarified and disinfected water before pumping to filter units
15	Pressure sand filter	Filtration of clarified water using sand and anthracite coal dual media for better results
16	Activated carbon filter	Filtration of clarified water using activated carbon filter
17	Treated water tank	This unit is used for holding filtered clear water
18	Sludge sump	Sludge from clarified is collected and transferred to sludge thickener
19	Sludge thickener	Sludge is thickened in gravity separation and supernatant is directed to equalisation tank
20	Centrifuge	Thickened sludge is further solidified by centrifugal action in a mechanical equipment

Table 12 Components of sewage treatment system

4.3 INITIAL COMPONENTS OF TREATMENT

In the following sections, pre-treatment of the raw sewage before entering equalisation tank is illustrated. The characteristics of the raw sewage and treated sewage are taken from the observation of similar environment adopting conservative values. This is due to the absence of reliable data from the test results of laboratory analysis of samples. The characteristics of the raw sewage and expected treated water is also described below for the design of the STP with Moving Bed Bio Film Reactor (MBBR).

In the following section, the design of pre-treatment units is described in detail. There is a co-treatment unit separately provided to receive septage load collected from various points after desludging activities. The septage is diluted in a water tank with specified dilution ratio to obtain desirable values of COD, BOD and TSS. There are receiving chambers for both septage and sewage loads. Oil and grease trap unit is used to remove oil and grease generated from kitchen and wash water flows. Manual coarse and fine screen channel is used to remove physical impurities of size greater than 20 mm and 6 mm respectively. A grit separator is given to remove fine particles of size 0.15 mm and above. There are odour control units also, especially for the co-treatment units.

4.3.1 UNIT OPERATIONS

DESIGN OF STP WITH MOVING BED BIOFILM-REACTOR (MBBR)						
Average flow from network	1	MLD				
Working hours	23					

Flow from septage dilution tank	12.63	m^3/hour	0.30	MLD		
Design flow	1.35	MLD	1346577	LPD	1347	m^3/day
			1347	KLD	56.11	m^3/hour
Assumed peak factor	2.25					
Peak design flow	3.03	MLD	3029798	LPD	3030	m^3/day
					126.2	m^3/hour
Raw Sewage Characteristics						
Average sewage flow entering the STP	56.11	m^3/hour				
Peak flow entering the STP	126.24	m^3/hour				
COD	500	mg/l				
Primary ST/ET effluent BOD	250	mg/l				
Thickener overflow return as fraction of plant flow	0.15					
Thickener overflow return	0.202	MLD				
Thickener overflow return BOD	350	mg/l				
Centrate from sludge dewatering as fraction of plant flow	0.006					
Centrate from sludge dewatering return	0.00808	MLD				
Centrate from sludge dewatering return BOD	280	mg/l				
Influent BOD to aeration tank	263.1	mg/l				
TSS	400	mg/l				
Total Nitrogen (As N)	40	mg/l				
Total Phosphorous (As P)	7	mg/l				
Faecal Coliform	30000000	mpn/100 ml				
E Coliform	40000000	mpn/100 ml				
Chlorides as Cl	125	mg/l				
pH	6					
Treated Sewage Characteristics (after filtration)						
COD	50	mg/l				
BOD	10	mg/l				
TSS	20	mg/l				
Total Nitrogen (As N)	10	mg/l				
Total Phosphorous (As P)	1	mg/l				
E Coliform	100	mpn/100 ml				
pH	7					
Receiving Chamber						
Average quantity of flow	56.11	m^3/hour				
Peak flow	126.24	m^3/hour				
	0.0351	m^3/sec				
Average Retention Time for peak flow	180	sec	offset to wall	0.3	m	
Volume of the inlet chamber	6.31	m^3	free board	0.85	m	
Assumed depth of flow	2.1	m	total height	2.95	m	
Area required for inlet chamber	3.01	m^2	wall thickness	0.25	m	

Length of the tank	2.5	m	slab thickness	0.3	m	
Breadth of the tank	1.20	fix	1.5	m	area in m^2	9.36
Oil and Grease Trap						
Average quantity of flow	56.11	m^3/hour				
Peak flow	126.24	m^3/hour				
	0.0351	m^3/sec				
Average Retention Time for peak flow	300	sec	offset to wall	0.15	m	
Volume of the inlet chamber	10.52	m^3	free board	0.75	m	
Assumed depth of flow	2.5	m	total height	3.25	m	
Area required for inlet chamber	4.21	m^2	wall thickness	0.3	m	
Length of the tank	2.8	m	slab thickness	0.35	m	
Breadth of the tank	1.50	fix	1.5	m	area in m^2	8.88
Breadth of baffle wall inside	1.5	m				
Manual Coarse Screen Channel						
Peak design flow	0.0351	m^3/sec				
Number of screen	1					
Peak flow rate per screen	0.0351	m^3/sec				
Velocity at peak flow	1	m/sec	assumed			
Velocity through clean bar screen	1.10	m/sec				
Length of channel U/S	1	m	wall thickness	0.25	m	
Width of channel provided	0.75	m	offset to wall	0.25	m	
Depth of flow	0.05	m	slab thickness	0.30	m	
Area required for screen	0.04	sqm				
Headloss through bar screen	0.02	m	*assuming head loss coefficient = 0.7*			
Assumed depth of flow after inserting bar screen	0.1	m	0.06	(control value)		
Width of channel required	0.35	m	fix	0.75	m	
Clear bar spacing	20	mm	*(20 to 50 mm)*			
Bar thickness	10	mm	*(5 to 15 mm)*			
Number of bars	25					
Clear bar spacing obtained	21	mm	OK			
Inside width of screen (openings)	0.5	m			area in m^2	3.85
Full height of channel	1.2	m	fb	0.3		
Angle of inclination	45	degree	0.79	rad		
Actual velocity at peak flow	1.13	*(between 0.60 m/sec and 0.90 m/sec)*				
Length of channel required D/S	1.20	m	fix	1.2	m	
Manual Fine Screen Channel						
Peak design flow	0.0351	m^3/sec				
Number of screen	1.2					
Peak flow rate per screen	0.0292	m^3/sec				

Velocity at peak flow	0.7	m/sec	assumed			
Velocity through clean bar screen	1.00	m/sec				
Length of channel U/S	1	m	wall thickness	0.25	m	
Width of channel provided	0.75	m	offset to wall	0.25	m	
Depth of flow	0.07	m	slab thickness	0.30	m	
Area required for screen	0.04	sqm				
Headloss through bar screen	0.04	m	*assuming head loss coefficient = 0.7*			
Assumed depth of flow after inserting bar screen	0.1	m	0.10	(control value)		
Width of channel required	0.42	m	fix	0.75	m	
Clear bar spacing	6	mm	*upto 6 mm*			
Bar thickness	10	mm	*(5 to 15 mm)*			
Number of bars	47					
Clear bar spacing obtained	6	mm	OK			
Inside width of screen (openings)	0.28	m			area in m^2	4.375
Full height of channel	1.5	m	fb	0.3		
Angle of inclination	45	degree	0.79	rad		
Actual velocity at peak flow	1.00	*(between 0.60 m/sec and 0.90 m/sec)*				
Length of channel required D/S	1.50	m	fix	1.5	m	
Daily screening quantity						
Daily sewage quantity	1346.58	m^3/day				
Rate of screening quantity	0.015	m^3/1000 m^3				
Daily screening quantity	0.0202	m^3/day				
Grit Separator						
Number of grit units	1	SB	0			
Peak flow	0.0351	m^3/sec				
Flow in one unit	0.0351	m^3/sec				
Grit particle size	0.15	mm				
HRT	60	sec	*(45 to 90 sec, typical 60)*			
Volume of grit chamber	2.10	m^3				
SOR	900	m^3/m^2/day	*(Empirical, from observations)*			
	0.010	m^3/m^2/sec				
Area required	3.37	m^2	wall thickness	0.30	m	
SWD	2.50	m	slab thickness	0.30	m	
Side of square channel	1.83	m	offset to wall	0.3	m	
Fix length	2.5	m	freeboard	0.8	m	
Fix width	2	m	area given	5	m^2	OK
Shape factor	0.85		volume given	12.5000	m^3	OK
Specific gravity of liquid	2.65					
Kinematic viscosity	1.003E-06	m^2/sec				

V_p in m/sec	0.020	*let Nr < 1, apply Stoke's law to get terminal velocity vp*				
N_r	3	*apply Newton's equation*				
assumed velocity in m/sec	0.0146					
Nr	2		area in m^2			11.84
drag coefficient Cd	15.47					
vp in m/sec	0.014					
Critical displacement velocity, Vc	0.0145	m/sec		R_t	1.00	
Horizontal velocity of flow, Vh	0.0070	m/sec	OK	R_v	2.06	

4.4 DESIGN OF CO-TREATMENT UNITS FOR SEPTAGE

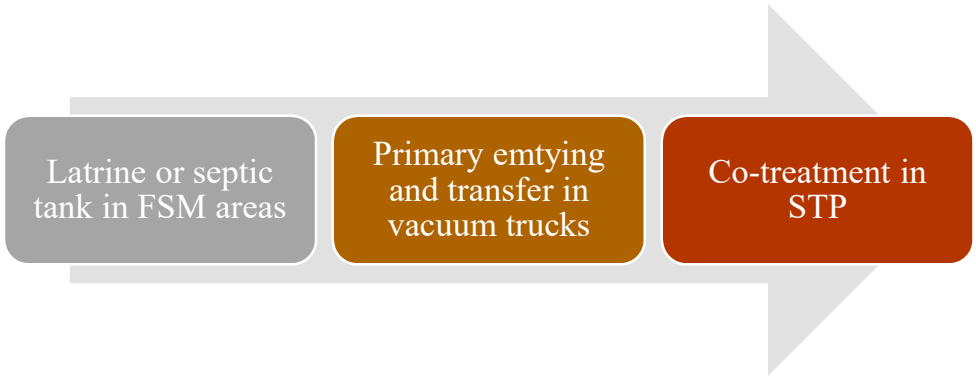


Fig.23 Septage Management, Containment, Emptying, Transportation, Treatment, End Use / Disposal

For the areas considered as septage zones, the households, institutions, commercial entities etc., shall undertake de-sludging of the septic tanks and pit once in every three years or when get filled up whichever is earlier as per the NBC code and CPHEEO guidelines. The most satisfactory method of sludge removal is by vacuum tankers. Though de-sludging frequencies vary, it is generally recommended to de-sludge tanks once every two to three years, or when the tank becomes one third full. Periodical de-sludging also helps to reduce the pollution levels in the liquid effluent, which normally enters waterways untreated. However, a small amount of sludge should be left in the tank to ensure that a minimum level of the necessary microorganisms responsible for anaerobic digestion remain in the tank. The gas generated due to anaerobic digestion might escape when tank is open for de-sludging. Hence, it is highly advisable to avoid using fire (or any incendiary material) in these cases. Regular de-sludging activities require well-organized community and public/private service providers. Because of the delicate nature of septic systems housing microbial processes, care should also be taken not to scrub the septic clean or use chemicals such as detergents etc. to avoid the complete destruction of favorable microbes in the tank.

4.4.1 UNIT OPERATIONS

The septage collected and transported to the STP is diluted in the tank by adding recycled water. The normalized values of BOD and TSS are calculated based on test results on samples performed. The detailed design is presented below:

DESIGN OF CO-TREATMENT UNIT FOR SEPTAGE WITH MOVING BED BIOFILM-REACTOR (MBBR)						
Design population	58000					
Sludge deposit coefficient	95	litres/person/year				
Sludge deposit	15.10	KLD				
Average septage flow	15.1	KLD				
Working hours	24					
Design flow	15.10	KLD	15100	LPD	15.1	m^3/day
Maximum peak factor expected	1.5		15	KLD	0.63	m^3/hour
Peak design flow	22.65	KLD	22650	LPD	23	m^3/day
					0.94	m^3/hour
Number of trips/days	8				0.0002	cum/sec
Quantity of septage obtained in single trip with peak factor	2.83	m^3				
Raw Septage Characteristics						
COD	25000	mg/l				
BOD	5000	mg/l				
TSS	7000	mg/l				
Treated Sewage Characteristics (after filtration)						
COD	50	mg/l				
BOD	10	mg/l				
TSS	20	mg/l				
Receiving Chamber						
Average quantity of flow	0.63	m^3/hour				
Peak flow	0.94	m^3/hour				
	0.00026	m^3/sec				
Average Retention Time for peak flow	600	sec	offset to wall	0.3	m	
Volume of the inlet chamber	0.1573	m^3	free board	0.85	m	
Assumed depth of flow	1	m	total height	1.85	m	
Area required for inlet chamber	0.16	m^2	wall thickness	0.25	m	
Length of the tank	1	m	slab thickness	0.3	m	
Breadth of the tank	0.16	fix	0.5	m	area in m^2	3.36
Design of Dilution Chamber from Mass-balance Principle						
Target outflow BOD (actual incoming BOD to STP)	265	mg/l	offset to wall	0.45	m	
Target outflow TSS (actual incoming TSS to STP)	400	mg/l	free board	0.85	m	
Volume of recycled water used for dilution	54000	litres	total height	3.35	m	
Quantity of septage obtained as above	2.83	m^3				
BOD of diluted septage	258.59	mg/l	ok			
TSS of diluted septage	367.73	mg/l	ok			
Total volume of dilution tank	56.83	m^3				
Liquid depth adopted inside dilution tank	2.50	m	wall thickness	0.3	m	

side of square tank	4.77	m	slab thickness	0.45	m	
Length of dilution tank adopted	6.00	m				
Breadth of dilution tank adopted	4.00	m	ratio of dilution		19.07	
Average outflow from dilution tank	12.63	m^3/hour	volume	60.00	m^3	ok
Average sewage flow entering the STP with diluted septage	8.00	m^3/hour	% of diluted septage to sewage			157.86
Oil and Grease Trap						
Average quantity of flow	12.63	m^3/hour				
Peak flow	18.94	m^3/hour				
	0.00526	m^3/sec				
Average Retention Time for peak flow	300	sec	offset to wall	0.15	m	
Volume of the inlet chamber	1.58	m^3	free board	0.75	m	
Assumed depth of flow	1.5	m	total height	2.25	m	
Area required for inlet chamber	1.05	m^2	wall thickness	0.25	m	
Length of the tank	1.5	m	slab thickness	0.3	m	
Breadth of the tank	0.70	fix	0.75	m	area in m^2	3.565
Breadth of baffle wall inside	0.75	m				
Manual Coarse Screen Channel						
Peak design flow	0.00526	m^3/sec				
Number of screen	1					
Peak flow rate per screen	0.0053	m^3/sec				
Velocity at peak flow	0.8	m/sec	assumed			
Velocity through clean bar screen	0.85	m/sec				
Length of channel U/S	1	m	wall thickness	0.25	m	
Width of channel provided	0.6	m	offset to wall	0.25	m	
Depth of flow	0.01	m	slab thickness	0.30	m	
Area required for screen	0.01	sqm				
Headloss through bar screen	0.01	m	*assuming head loss coefficient = 0.7*			
Assumed depth of flow after inserting bar screen	0.1	m	0.02	(control value)		
Width of channel required	0.07	m	fix	0.6	m	
Clear bar spacing	20	mm	*(20 to 50 mm)*			
Bar thickness	10	mm	*(5 to 15 mm)*			
Number of bars	15					
Clear bar spacing obtained	32	mm	OK			
Inside width of screen (openings)	0.45	m			area in m^2	4
Full height of channel	1.5	m	fb	0.3		
Angle of inclination	45	degree	0.79	rad		
Actual velocity at peak flow	0.69	*(Between 0.60 m/sec and 0.90 m/sec)*				
Length of channel required D/S	1.50	m	fix	1.5	m	

Sewage pump- for pumping to receiving chamber/equalisation tank of STP						
Number of pumps	1	SB	1			
Type of pump set	submersible centrifugal sewage transfer-non clog					
Average flow	12.63	m^3/hour				
Peak design flow	18.94	m^3/hour				
Working hours	23					
Flow capacity of each pump	19.77	m^3/hour				
Peak factor	1.20					
Discharge	6.59	LPS	0.0066	m^3/sec		
Head required	18	m				
Efficiency	50%					
Power required	3.16	HP	fix	3.25	HP	
Energy	54.27	kwh				

Recycled water pump- for pumping to dilution tank						
Number of pumps	1	SB	1			
Type of pump set	submersible centrifugal sewage transfer-non clog					
Average flow	12.00	m^3/hour				
Peak design flow	18.00	m^3/hour				
Working hours	23					
Flow capacity of each pump	18.78	m^3/hour				
Peak factor	1.20					
Discharge	6.26	LPS	0.0063	m^3/sec		
Head required	20	m				
Efficiency	50%					
Power required	3.34	HP	fix	3.5	HP	
Energy	57.29	kwh				

4.5 DESIGN OF EQUALISATION TANK

Equalisation tank is used to normalise the flow towards chemical and biological processing units. This unit has been designed in accordance with the observation of flow for 24 hours in similar cases. A peak factor is obtained from the observed data for both BOD loading and discharge. The equalisation tank will store liquid during excess flow periods and release quantity during off-peak flow periods. The volume of equalisation tank is scientifically designed based on this concept. Hence there will be a normalised value for influent BOD also.

4.5.1 UNIT OPERATIONS

Equalization Tank						
Average design flow	56.11	m^3/hour				
Volume of tank required	350.00	m^3	*from detailed analysis*			
HRT	6.24	hours				
SWD	3.6	m				
Area required for equalization tank	97.22	m^2	free board	0.50	m	

Number of tanks proposed	1		offset to wall	0.45	m	
Area required for each tank	97.22	m^2	wall thickness	0.3	m	
Diameter of circular tank	11.13	m	fix	11.2	m	
Side if square tank	9.86	m	fix length	10	m	
Thickness of foundation slab	0.45	m	fix breadth	10	m	
Actual capacity provided	354.7	m^3	circular	OK		
	360	m^3	rectangular	OK	area in m^2	132.2

4.6 DESIGN OF MBBR UNITS

Biochemical oxygen demand (BOD) is an indirect measure of the concentration of biodegradable organic matter in water or wastewater. Organic matter (as measured by BOD) is one of the major constituents removed from wastewater in domestic wastewater treatment plants. The reason for being concerned about organic matter in water is its effect on dissolved oxygen in the receiving stream. Dissolved oxygen in water is essential for much of aquatic life, so organic contaminants that affect dissolved oxygen level in water are of concern.

The two major reactions that take place in the organic carbon cycle are biological oxidation of waste organic matter and photosynthesis, which is the process by which green plants produce organic matter from carbon dioxide and water in reactions that are catalysed by sunlight and the chlorophyll in the green plants. Through the biological oxidation process, aerobic microorganisms utilize oxygen in breaking down organic matter to carbon dioxide and water together with small amounts of other end products.

The photosynthesis and biological oxidation processes can be represented by the following two equations:

Photosynthesis:

CO_2 + H_2 O + sunlight → organic plant matter (primarily C, H, & O) + oxygen (this reaction is catalysed by the chlorophyll in green plants)

Biological Oxidation:

waste organic matter (primarily C, H & O) + O_2 → CO_2 + H_2O + energy

The process takes place as aerobic microorganisms utilize the waste organic matter as their food (energy) source. The process uses oxygen, so if it is taking place in a water body, dissolved oxygen is consumed. A large quantity of organic matter in the water will result in multiplication of microorganisms and rapid removal of dissolved oxygen, leading to oxygen depletion below the level needed by aquatic life. This is also the process that takes place in biological oxidation processes in wastewater treatment plants for removal of organic matter from the incoming wastewater.

The MBBR process for wastewater treatment was invented and initially developed by Professor Hallvard Ødegaard in the late 1980s at the Norwegian University of Science and Technology. Use of this wastewater treatment process has spread rapidly.

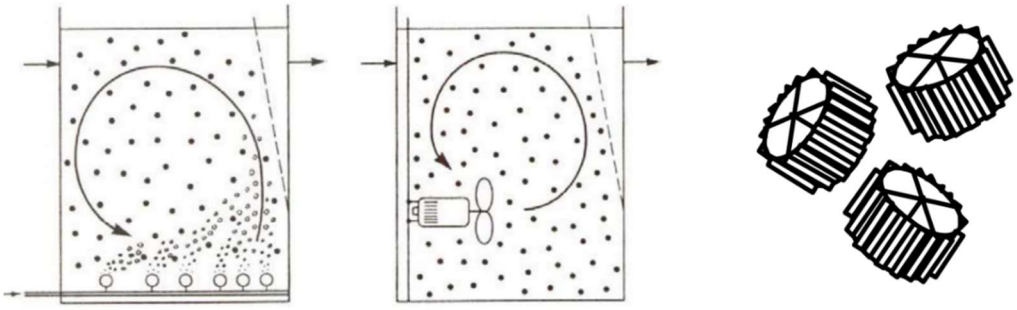
The MBBR process is an attached growth biological wastewater treatment process. That is, the microorganisms that carry out the treatment are attached to a solid medium, as in trickling filter or RBC systems. By contrast, in a suspended growth biological wastewater treatment process, like the activated sludge process, the microorganisms that carry out the treatment are kept suspended in the mixed liquor in the aeration tank. In the conventional attached growth biological treatment processes, like trickling filter or RBC systems the microorganisms are attached to a medium that is fixed in place and the wastewater being treated flows past the surfaces of the medium with their attached biological growth. which are described in more detail in the next section. The MBBR treatment processes typically take place in a tank like an activated sludge aeration tank. In contrast, an MBBR process utilizes small plastic carrier media, which are kept suspended by a diffused air aeration system for an aerobic process or by a mechanical mixing system for an anoxic or anaerobic process. A sieve is typically used at the tank exit to keep the carrier media in the tank.

MBBR processes use plastic media support carriers like those shown in Figure 11. As shown in Figure, the carrier is typically designed to have a high surface area per unit volume, so that there is a lot of surface area on which the microorganisms attach and grow. Two properties of the carrier are needed for the process design calculations are the specific surface area in m^2/m^3 and the void ratio. The specific surface area of MBBR carriers is typically in the range from 350 to 1200 m^2/m^3 and the void ratio typically ranges from 60% to 90%. Design values for these carrier properties should be obtained from the carrier manufacturer or vendor (Harlan H. Bengtson).

The MBBR wastewater treatment process is quite flexible and can be used in several different ways:

1. Single stage BOD removal 2. Two stage BOD removal 3. Two stage BOD removal and Nitrification 4. Single stage tertiary Nitrification 5. Pre-Anoxic Denitrification 6. Post-Anoxic Denitrification (Harlan H. Bengtson).

The idea behind the development of the moving bed biofilm process was to adopt the best from both the activated sludge process and the biofilter processes without including the worst. Contrary to most biofilm reactors, the moving bed biofilm reactor utilises the whole tank volume for biomass growth, as does also the activated sludge reactor. Contrary to the activated sludge reactor, it does not need any sludge recycle, as also the case in other biofilm reactors. This is achieved by having the biomass grow on carriers that move freely in the water volume of the reactor, kept within the reactor by a sieve arrangement at the reactor outlet. Since no sludge recirculation takes place, only the surplus biomass must be separated – a considerable advantage over activated sludge process. The reactor may be used for both aerobic, anoxic or anaerobic processes (H. Ødegaard).



a. Aerobic reactor b. Anoxic and anaerobic reactor c. The biofilm carrier (K1)

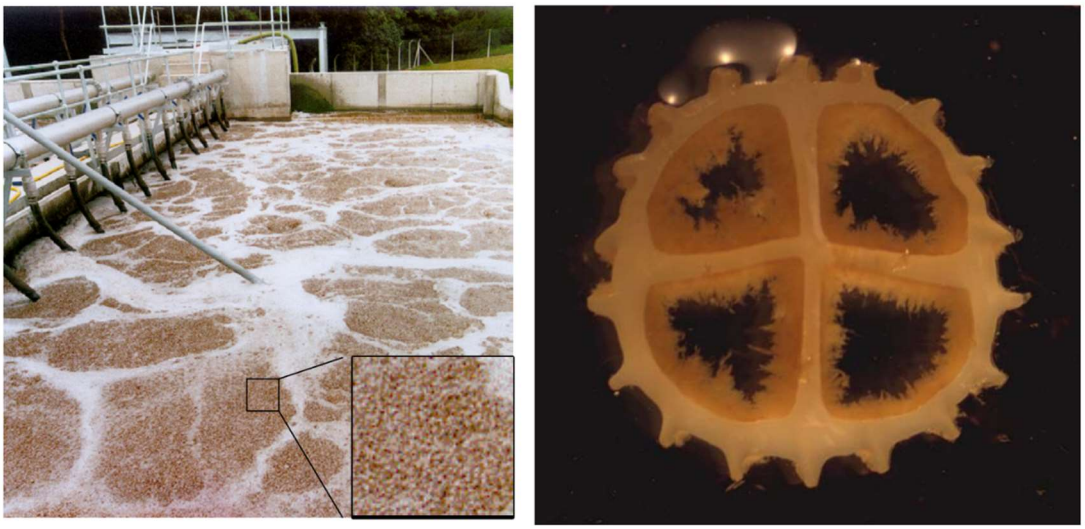


Fig.24 MBBR Carrier media in a MBBR tank

The key design parameter for sizing the MBBR tank is the surface area loading rate (SALR), typically with units of g/m^2 /day, that is g/day of BOD coming into the MBBR tank per m^2 of carrier surface area. Using design values for wastewater flow rate and BOD concentration entering the MBBR tank, the loading rate in g BOD/day can be calculated. Then dividing BOD loading rate in g/day by the SALR in g/m^2 /day gives the required carrier surface area in m^2. The carrier fill %, carrier specific surface area, and carrier % void space can then be used to calculate the required carrier volume, tank volume and the volume of liquid in the reactor (Harlan H. Bengtson).

To carry out denitrification of a wastewater flow (removal of the nitrogen from the wastewater), it is necessary to first nitrify the wastewater, that is, convert the ammonia nitrogen typically present in the influent wastewater to nitrate. Nitrification will only take place at a reasonable rate if the BOD level is quite low. Thus, an MBBR denitrification process will need a reactor for BOD removal, one for nitrification, and one for denitrification. The nitrification reactor will always follow the BOD removal reactor, because of the need for a low BOD level in the nitrification reactor. The denitrification reactor may be either before the BOD removal reactor (called pre-anoxic denitrification) or after the nitrification reactor (called post-anoxic denitrification).

The denitrification reactions, which convert nitrate ion to nitrogen gas, and hence remove it from the wastewater flow, will take place only in the absence of oxygen, that is, in an anoxic reactor. Also, the

denitrification reactions require a carbon source. In a pre-anoxic denitrification process, the BOD in the primary effluent wastewater is used as the carbon source for denitrification. In this process, however the primary effluent entering the pre-anoxic reactor still has ammonia nitrogen present rather than the nitrate nitrogen needed for denitrification.

In a post-anoxic denitrification process, the influent to the denitrification reactor comes from the nitrification reactor, so the wastewater influent ammonia nitrogen has been converted to nitrate as required for denitrification. The BOD has also been removed prior to the post anoxic denitrification reactor, however, so an external carbon source is required for the denitrification reactions.

The pre-anoxic denitrification process has the advantage of not requiring an external carbon source and it reduces the BOD load to the BOD removal part of the process because BOD is used in the denitrification reactions. However, the pre-anoxic process requires an influent C/N ratio greater than 4, where C/N is taken to be BOD/TKN, and the post-anoxic process can achieve a more complete nitrogen removal. In the present project, post-anoxic de-nitrification process is adopted to address the issues expected during the occurrence of higher values of total nitrogen in the incoming sewage load.

At each operation in reactor, the influent and effluent characteristics are monitored and if possible after de-nitrification the effluent can be directly taken for clarification. Also, there are provisions for bypassing de-nitrification reactor also. However, all these decisions largely depends upon the operational efficiency and continuous monitoring of the parameters in effluent at each stage.

4.6.1 PROCESS ANALYSIS AND DESIGN

Sewage pump- for pumping to MBBR tank						
Number of pumps	1	SB	1			
Type of pump set	submersible centrifugal sewage transfer-non clog					
Average flow	1346.58	m^3/day				
Peak design flow	3029.80	m^3/day				
Working hours	23					
Flow capacity of each pump	58.55	m^3/hour				
Peak factor	1.20					
Discharge	19.52	LPS	0.0195	m^3/sec		
Head required	12	m				
Efficiency	60%					
Power required	5.20	HP	fix	5.5	HP	
Energy	89.29	kwh				
Moving Bed Bio-Reactor (MBBR)-Single Stage						
Average design flow	1346.58	m^3/day				
Number of streams	1					
BOD of incoming sewage	263.13	mg/l				
TSS of incoming sewage	400	mg/l				
BOD expected after treatment	10	mg/l				

BOD to be removed	253.13	mg/l				
BOD removal % expected	96.20					
Number of tanks proposed	1					
BOD loading rate/volume	4	kg/m^3/day	*4-7 kg/m^3/day as per M&E*			
Actual BOD loading rate	354.33	kg/day				
Quantity of BOD to be removed per day	340.86	kg/day				
Volume of reactor required	88.58	m^3				
Surface area loading rate (SALR) for BOD removal	7.50	g/m^2/day				
Required carrier surface area	47243.57	m^2				
Specific surface area of carrier	600.00	m^2/m^3				
Required carrier volume	78.74	m^3				
Volume of media required	40%					
	35.43	m^3	depth of base	0.9	m	
Volume of tank required-BOD loading rate/volume method	124.01	m^3	slab thickness	0.35	m	
Volume of tank required- SALR method	196.85	m^3	offset to wall	0.45	m	
Volume of each tank	196.85	m^3	total height	4.10	m	
SWD	3.6	m	wall thickness	0.30	m	
Area of each tank	54.68	m^2	fix dia	8.4	m	
Diameter of circular tank	8.34	m	length	7.4	m	
Side of square tank	7.39	m	breadth	7.4	m	
Actual capacity provided-circular	199.50	m^3	OK			
Actual capacity provided-rectangular	197.14	m^3	OK			
Fix capacity	197.14	m^3				
Actual volume of media obtained	78.86	m^3				
Actual carrier surface area	47313.60	m^2				
Volume of liquid in the tank	165.60	m^3				
Hydraulic Retention Time at design average flow	2.95	hours	177.1	minutes		
Hydraulic Retention Time at peak flow	1.31	hours	78.7	minutes		

SARR for the given SALR	6.94	g/m^2/day		area in m^2		79.21
Estimated BOD removal rate	328.24	kg/day				
Actual BOD removal rate %	92.64	BOD of effluent		19.37	mg/l	not ok
Moving Bed Bio-Reactor (MBBR)-Single Stage Nitrification						
Average design flow	1346.58	m^3/day				
Number of streams	1					
BOD of incoming sewage	20.00	mg/l				
NH_4-N of incoming sewage	40.00	mg/l				
Alkalinity as $CaCO_3$	140.00	mg/l				
Target effluent NH_3-N	3.30	mg/l	% removal	91.75		
DL level to be maintained in tank	2.00	mg/l				
Design minimum waste water temperature	20.00	^{o}C				
$SARR_{max}$	0.61	SARR temp coefft. Θ			1.058	
Minimum NH_3-N at $SARR_{max}$	0.50		$SARR_T$	0.81	g/m^2/day	
Design value of SALR	0.88	g/m^2/day				
NH_3-N loading rate	53.86	kg/day				
Required carrier surface area	61113.77	m^2/day				
Specific surface area of carrier	600.00	m^2/m^3				
Required carrier volume	101.86	m^3/day	depth of base	0.65	m	
Volume of media required	40%		slab thickness	0.35	m	
Volume of tank required- SALR method	254.64	m^3	offset to wall	0.45	m	
Volume of each tank	254.64	m^3	total height	4.10	m	
SWD	3.6	m	wall thickness	0.30	m	
Area of each tank	70.73	m^2	fix dia	9.5	m	
Diameter of circular tank	9.49	m	length	8.45	m	
Side of square tank	8.41	m	breadth	8.45	m	
Actual capacity provided-circular	255.18	m^3	OK			
Actual capacity provided-rectangular	257.05	m^2	OK			
Fix capacity	257.05	m^3				
Actual volume of media obtained	102.82	m^3				
Actual carrier surface area	61692.00	m^2			area in m^2	99.00
Volume of liquid in the tank	215.92	m^3				

Hydraulic Retension Time at design average flow	3.85	hours	230.90	minutes		
Hydraulic Retension Time at peak flow	1.71	hours	102.62	minutes		
BOD SALR	0.44	$g/m^2/day$	*should be < 0.5 to achieve good nitrification*			
Using the equivalent weight of $CaCO_3$ as 50, the equivalent weight of $NaHCO_3$ as 84, the alkalinity use for nitrification as 7.14 g $CaCO_3$/g NH_3-N and the target effluent alkalinity as 80 mg/L as $CaCO_3$, give the calculated alkalinity requirement as 118.5 mg/L as $CaCO_3$.						
Influent alkalinity	140.00	mg/l				
Target effluent alkalinity	80.00	mg/l				
Alkalinity used for Nitrification	7.14	g $CaCO_3$/g NH_3-N				
Alkalinity to be added	202.04	mg/l				
Rate of alkalinity addition needed as $CaCO_3$	272.06	kg/day				
Equiv wt. of $CaCO_3$	50.00	g/equivalent				
Equiv wt. of $NaHCO_3$	84.00	g/equivalent				
Daily $NaHCO_3$ requirement	457.06	kg/day $NaHCO_3$				
Moving Bed Bio Reactor (MBBR)-post-anoxic denitrification						
Carbon:Nitrogen ratio (C/N)	6.58					
Average design flow	1347	m^3/day				
Number of post-anoxic tanks	1.00					
Target effluent NO_3-N concentration	4.00	mg/l				
SALR for post-anoxic stage	2.00	g NO_3 N /m^2/day				
Estimate of SARR/SALR ratio	0.886	mg/l				
Target % N removal	91.75					
Specific surface area of carrier	600.00	m^2/m^3				
NO_3-N daily loading rate	49.42	kg/day				
Required carrier surface area	24709.687	m^2				
Required carrier volume	41.18	m^3				
Volume of media required	40%		depth of base	0.65	m	
Volume of tank required- SALR method	102.96	m^3	slab thickness	0.35	m	
Volume of each tank	103.0	m^3	offset to wall	0.45	m	
SWD	3.6	m	total height	4.10	m	
Area of each tank	28.60	m^2	wall thickness	0.30	m	
Diameter of circular tank	6.03	m	fix	6.1	m	

Side of square tank	5.35	m	length	5.4	m	
Actual capacity provided-circular	105.21	m^3	breadth	5.4	m	
Actual capacity provided-rectangular	104.98	m^3	OK			
Fix capacity	104.98	m^3	OK			
Actual volume of media obtained	41.99	m^3				
Actual carrier surface area	25195.20	m^2				
Volume of liquid in the tank	88.18	m^3				
Hydraulic Retension Time at design average flow	1.57	hours	94.30	hours		
Hydraulic Retension Time at peak flow	0.70	hours	41.91	hours		
SARR	1.77	$g/m^2/day$				
Estimated NO_3-N removal rate	44.65	kg/day				
NO_3-N of effluent	3.54	mg/l				
Alkalinity produced by denitrification	3.57	g $CaCO_3$/g NO_3-N removed				
Actual alkalinity to be added	83.66	mg/l				
Rate of alkalinity addition needed as $CaCO_3$	112.65	kg/day				
Equiv wt. of $CaCO_3$	50.00	g/equivalent				
Equiv wt. of $NaHCO_3$	84.00	g/equivalent				
Daily $NaHCO_3$ requirement	189.26	kg/day $NaHCO_3$				
4.6 lb COD/lb NO_3-N removed and 1.5 lb COD/lb Methanol. The required methanol dosage is then calculated as: 4.6/1.5 = 3.1 lb methanol /lb NO_3-N removed. The methanol requirement in lb/day is then equal to 3.1 times the previously calculated NO_3-N removal rate						
Methanol requirement in kg/day	153.20	kg/day				
Considering toxicity, economy and safety considerations it is better to adopt retrun activated sludge feed into anoxic tank for carbon source. Alkaline fermentation can be adopted for better results.						
Design of mechanical mixer for denitrification tank						
Capacity of de-nitrification tnk provided	104.98	m^3				
Hydraulic Retension Time	1.57	hours				
Mixing rate	0.5	m^3/hour				
Capacity of mixer	133.59	m^3/hour				
Power transferred in mixing	5	Watts/m^3				
Power required for mixer	0.90	HP	fix	1	HP	
Energy	17.16	kwh				
Moving Bed Bio-Reactor (MBBR) chamber after de-nitrification						
Average design flow	1346.58	m^3/day				

Number of streams	1					
BOD of incoming sewage (including return activated sludge as carbon source)	86.83	mg/l				
TSS of incoming sewage	50	mg/l				
BOD expected after treatment	7	mg/l				
BOD to be removed	79.83	mg/l				
BOD removal % expected	91.94					
Number of tanks proposed	1					
BOD loading rate/volume	4	$kg/m^3/day$	*4-7 $kg/m^3/day$ as per M&E*			
Actual BOD loading rate	116.93	kg/day				
Quantity of BOD to be removed per day	107.50	kg/day				
Volume of reactor required	29.23	m^3				
Surface area loading rate (SALR) for BOD removal	15.00	$g/m^2/day$				
Required carrier surface area	7795.19	m^2				
Specific surface area of carrier	600.00	m^2/m^3				
Required carrier volume	12.99	m^3				
Volume of media required	35%					
	10.23	m^3	depth of base	0.45	m	
Volume of tank required-BOD loading rate/volume method	39.46	m^3	slab thickness	0.35	m	
Volume of tank required- SALR method	37.12	m^3	offset to wall	0.45	m	
Volume of each tank	39.46	m^3	total height	4.10	m	
SWD	3.6	m	wall thickness	0.30	m	
Area of each tank	10.96	m^2	fix dia	3.75	m	
Diameter of circular tank	3.74	m	length	3.35	m	
Side of square tank	3.31	m	breadth	3.35	m	
Actual capacity provided-circular	39.76	m^3	OK			
Actual capacity provided-rectangular	40.40	m^3	OK			
Fix capacity	40.40	m^3				
Actual volume of media obtained	14.14	m^3				

Actual carrier surface area	8484.00	m^2				
Volume of liquid in the tank	34.74	m^3				
Hydraulic Retension Time at design average flow	0.62	hours	37.2	minutes		
Hydraulic Retension Time at peak flow	0.28	hours	16.5	minutes		
SARR for the given SALR	13.13	$g/m^2/day$		area in m^2		23.52
Estimated BOD removal rate	111.35	kg/day				
Actual BOD removal rate %	95.23	BOD of effluent		4.14	mg/l	ok

Blower air requirement						
BOD loading	441.16	kg/day				
NH_3-N loading rate	53.86	kg/day				
Oxygen uptake ratio-BOD	1.50	kg of O_2/kg of BOD				
Oxygen uptake ratio-NH_3-N	4.57	kg of O_2/kg of NH_3-N				
Oxygen required for BOD loading	661.74	kg/day				
Oxygen required for NH_3-N loading	246.15	kg/day				
Percentage of O_2 in air	21.00					
Weight of air required-BOD loading	3151.14	kg/day				
Weight of air required-NH_3-N loading	1172.16	kg/day				
Density of air	1.225	kg/m^3				
Volume of air-BOD loading	2572.36	m^3/day				
Volume of air-NH_3-N loading	956.87	m^3/day				
Air transfer efficiency of diffuser	0.075					
Quantity of air required-BOD loading	34298.17	m^3/day				
Quantity of air required-NH_3-N loading	12758.24	m^3/day				
Factor of safety	1.20					
Volume of air required-BOD loading	1714.91	m^3/hour				
Volume of air required-NH_3-N loading	637.91	m^3/hour				
Volume of equalisation tank	350.00	m^3				
Normal inflow	0.016	m^3/sec				
Air requirement for equalisation tank	1.25	m^3/m^3/hour				
Air requirement for sludge tank	3.00	m^3/m^3/hour				
Volume of ET	350.00	m^3				
Volume of air required for ET	437.50	m^3/hour				

Volume of air required for ST	10.50	m^3				
Total air required	2800.82	m^3/hour				
Capacity of blower	2801.00	m^3/hour				
Number of blowers working	2.00	SB	1			
Air required per blower	1400.50	m^3/hour				
Pressure given	0.60	kg/cm^2	5.89	m		
Volumetric efficiency	60%					
Power required for blower motor	51.24	HP	38.23	kw		
Fix power of blower motor	52.00	HP				
Energy	1862.02	kwh				

4.7 DESIGN OF CLARIFIER

In the following sections, flocculation and clarification processes are described for the effluent from MBBR tanks. To achieve high degree of clarification, up flow hopper bottom type clarifier is used. The upper portion of the clarifier consists of the rectangular vessel in which tube settlers/plate settlers are installed for particle removal. Alum and Lime dosing is used for formation of aggregates or flocs from finely divided particles and from chemically destabilised particles. The settling of discrete, non-flocculating particles can be analysed by means of the classic laws of sedimentation formed by Newton and Stokes. The clarified is designed based on the various aspects of theory of sedimentation.

4.7.1 UNIT OPERATIONS

Alum solution tank						
number of units	1					
dosage of alum	50	ppm				
requirement for 8 hours	22.440	kg				
volume of solution at 10% strength/unit	0.2	m^3				
length of tank	0.6	m				
breadth of tank	0.6	m				
liquid depth	0.56	m				
total depth	1	m				
solution flow rate	0.0250	m^3/hour				
Lime solution tank						
number of units	1					
dosage of lime	35	ppm				
requirement for 8 hours	15.71	kg				
volume of solution at 10% strength/unit	0.14	m3				
length of tank	0.6	m				
breadth of tank	0.6	m				
liquid depth	0.39	m				
total depth	1	m				
solution flow rate	0.01750	m^3/hour				
Secondary Clarifier with Plate/Tube Settler						

Average output required from tube settler in MLD	1.347	56.11	m^3/hour	15.59	LPS	
Number of batteries	1					
Average design flow as input in MLD/unit	1.35	56.11	m^3/hour	15.59	LPS	
Width of plates in mm	900	space between plates		20	mm	23.10
Length of plates adopted in m	0.75					
Angle of inclination of tubes adopted in deg.	60	1.05	rad			
Relative length of settler (dimensionless) Lr = L/d	37.5	wall thickness		0.3	m	
Relative length is changed by L' = 0.058 x [Vo x d/v]		column size		0.35	m	
Where Vo is velocity of flow along tube settler		offset to wall		0.6	m	
v is kinematic viscosity of water		depth of raft		0.75	m	
Effective relative length of tube, L = Lr- [0.058 x Vo x d/v]		slab thickness		0.35	m	
Kinematic viscosity of water in m/day	0.087264	r-beam depth		0.6	m	
Effective relative length of tube/plate, L	37.5	(-)	0.013	Vo		
	34.50					
desirable value of relative length	*around 20 but below 40*					
for one unit:		freeboard		0.5	m	
Vertical water height in chamber in m	2.4		t-beam width	0.425	m	
Height of chamber in hopper portion in m	2.4		t-beam depth	0.45	m	
Side of large square in m	4.2		r-beam width	0.425	m	
Side of small square in m	1.5		inlet pipe dia	0.2	m	
h_3 in m (height of the truncated cone)	1.33					
Angle of inclination of hopper side to vertical	0.512	29.37	degree	60.63	*deg. with hor.*	
Larger inclined length L_i of slanting slab in m	4.28	area in m^2	9.00			
Smaller inclined length l_i of slanting slab in m	1.53	area in m^2	1.15			
Contact area in m^2	31.39					
SOR in m^3/m^2/day for upflow clarifier	42.90	<	50			
Trial volume in m^3 of one unit	63.08	volume of hopper in m^3			20.74	
Detention time in hours	1.12	in square	0.75	in hopper	0.37	hours
Fix volume	63.08	m^3				
Performance parameter of tube settler S = Vs/Vo x [sinθ + L x cosθ]						
For laminar flow regime, critical performance parameter value for complete removal of particle,						
Critical value of performance parameter, Sc =	1.333	circular				

	1.375	square				
	1	parallel plates				
Particle size in mm	0.025					
Settling velocity of particle in m/sec, V_s (laminar)	0.0006	m/sec	48.08	m/d		
Reynolds number, Nr	0.014					
Trial value of flow along plate settler V_o in m/day	226					
Shape of cross section of tubes	plates	(Square, circular, or plates)				
Critical of performance parameter obtained, Sc	[(Vs/Vo) x (sinθ+Lcosθ)					
	3.86					
Plate entrance area/one unit	5.71	m^2				
Number of modules of plates	2					
Number of plates required/module	158.61					
Fix number of plates required/module	158					
Length/module of tray holding plates	3900	mm				
Thickness of plate	1.5	mm				
Number of plates configured in one module	159.53	OK				
Height of plate module for 1m length of tubes inclined:	0.87					
Hence height of tube module	0.65	m				
Fix length of plate module	0.75	m				
Fix height of plate module	0.65	m				
Fix number of plates required per module	158					
Angle of inclination	60	degree to horizontal				
Contact area	213.3	m^2		area in m^2		36.00
SOR in m^3/m^2/day for plate settler	6.05	<	40			
Total plate entrance area	5.69	m^2				
Actual velocity of flow in m/day	226.88	*now correct velocity*				

4.8 DESIGN OF FILTER FEED, CHLORINE CONTACT UNITS AND PRESSURE FILTERS

Pressure filters are used for treatment of the clarified water in the next stage. Pressure Sand Filter is used for removal of suspended solids and turbidity from the effluent from clarifier. Clarified water is passed through the pressure sand filter, the filter media (Fine quartz sand) is supported on gravel and pebbles bed of progressively larger sizes. During the filtration cycle, the filter bed retains the dirt and suspended particles from the water and accumulates within the filter bed. Clear water can be collected from the outlet of filter. Frequent backwashing of the media is also required.

Activated carbon filter process basically absorbs unwanted contaminants from wastewater. Activated carbon is initially treated with oxygen. This helps the charcoal open millions of tiny pores. Activated carbon is highly effective when it comes to absorption of contaminants from water. Filtration process includes activated carbon to remove the residual contaminants from sewage. Carbon absorbs

micropollutants such as chlorine, methane, organic compounds, and even the taste and odour from water. Activated carbon filter removes chlorine from wastewater. It has a large surface area which makes it highly effective to absorb contaminants from wastewater. Chlorine removal process fills the wide pores of the carbon. Hence, impurities are removed. Activated carbon needs replacement as its capacity to work reduces gradually. This process involves a low operating cost. Carbon in the activated carbon filter process also absorbs organic compounds. The capacity of this process will depend on the physical properties of the surface area of the activated carbon, the amount of hydrogen and oxygen contains, the concentration level of the impurities, duration of the treatment, and of course the pH level of the water used.

Chlorination is used for disinfection of the clarified water which is collected in a filter feed tank. Using filter feed pump sets, the effluent is fed to the pressure sand and activated carbon filter units.

4.8.1 UNIT OPERATIONS AND STRUCTURAL DESIGN

Chlorine contact tank						
HRT	30	minutes	offset to wall	0.3	m	
Average flow	56.11	m^3/hour	wall thickness	0.3	m	
Volume of tank	28.05	m^3	slab thickness	0.35	m	
Assumed liquid depth	2	m	freeboard	0.35	m	
Area of the tank	14.03	m^2		area in m^2		24.50
side of square tank	3.75	m	fix	3.75	m	
Filter feed tank						
HRT	20	minutes	offset to wall	0.3	m	
Average flow	56.11	m^3/hour	wall thickness	0.25	m	
Volume of tank	18.70	m^3	slab thickness	0.3	m	
Assumed liquid depth	2	m	freeboard	0.35	m	
Area of the tank	9.35	m^2				
side of square tank	3.06	m	fix	3.1	m	
			fix breadth	3.1	m	
Volume provided	19.22	OK		area in m^2		17.64
Pressure Sand Filter						
Average flow	1346.58	m^3/day				
Filter operating hours	20	hours				
Operating flow	67.33	m^3/hour				
Filter Loading Rate	12	m^3/m^2/hour				
Area of the filter required	5.61	m^2				
Number of filters	1					
Area of each filter	5.61	sqm				
Diameter of filter required	2.67	m	fix	2.7	m	
Height of the filter	2.5	m	offset to wall	0.5	m	
Operating pressure	3.5	Bar				
Filter media	Sand			area in m^2		13.7
Activated Carbon Filter						
Average flow	1346.58	m^3/day				

Filter operating hours	20	hours				
Operating flow	67.33	m^3/hour				
Filter Loading Rate	10	m^3/m^2/hour				
Area of the filter required	6.73	m^2				
Number of filters	1					
Area of each filter	6.73	sqm				
Diameter of filter required	2.93	m	fix	3	m	
Height of the filter	2.5	m	offset to wall	0.5	m	
Operating pressure	3.5	Bar				
Filter media	Activated Carbon			area in m^2		16.00
Pump for clarified water to PSF and ACF						
Type of pump set	CF					
Number of pumps	1.00	W	1	SB	1	
Discharge of clarified water required	56.11	m^3/hour				
Working hours of pumps	20.00	hours				
Discharge required	67.33	m^3/hour	1.9E-02	m^3/sec		
Head required	35.00	m				
Efficiency	50%					
Power required	17.46	fix	17.50	HP		
Energy	260.44	kwh				
Treated Water Tank						
HRT	60	minutes	offset to wall	0.3	m	
Average flow	56.11	m^3/hour	wall thickness	0.25	m	
Volume of the tank	56.1	m^3	slab thickness	0.3	m	
Assumed liquid depth	2.5	m	freeboard	0.35	m	
Area of the tank	22.44	m^2				
Number of tanks	1		fix length	4.75	m	
Area of one tank	22.44	m^2	fix breadth	4.75	m	
Side of square tank	4.74	m				
Volume provided	56.41	m^3	OK			
Total area of units	332.98	m^2		area in m^2		34.22
Movement space factor	1.5					
Total area required	741.75	m^2				

STRUCTURAL DESIGN OF PRESSURE SAND FILTER					
Rate of filtration in normal working condition	[6000 to 15000 litres/hour/m^2]				
Rate of filtration adopted for design	12000	litres/hour/m^2			
	12	m^3	[safer side]		
Ultimate demand in MLD	1.35				
Hours of pumping adopted	20				
Actual ultimate discharge in MLD	1.62				
Allowance for wastage in %	1				
Design discharge adopted in MLD	1.632				
Area required in m^2	5.67				

Required diameter in m	2.69	[range is 0.30 to 2.75 m]			
Fix diameter in m	2.7	2700	mm		
Maximum pressure in kg/cm^2	4	0.408	Mpa		
Factored stress in Mpa	0.82				
Safe stress in steel in kg/cm^2					
	165	[mild steel]		minimum	
Safe stress for MS adopted in design in Mpa	110.55				
Required thickness for the cylindrical shell in mm	pd/2μ				
	9.96	fix	12	mm	
Required thickness for hemispherical part in mm	pd/4μ				
	4.98	fix	12	mm	
For the condition of no distortion at the junction, pd/4tc E [2-(1/m)] = pd/4ts E [1-(1/m)]					
ts/tc = 0.43 for 1/m = 0.25					
Then, thickness of spherical shell required in mm			5.16	ok	
For the condition of same maximum stress in cylindrical and hemispherical parts, pd/2tc = pd/4tc, ts/tc = 0.5					
Then, thickness of spherical shell required in mm			6	ok	
Hoop stress in cylindrical parts in Mpa			45.87156	ok	
Hoop stress in spherical parts in Mpa			22.93578	ok	
Hoop stress in spherical parts in Mpa if same thickness throughout			22.94	ok	
If top and bottom portions are not spherical, then provide parabolic dome of MS with same thickness of cylindrical portion					
Rise of the dome in mm			675		
Then, meridional stress in Mpa			32.81	ok	
STRUCTURAL DESIGN OF ACTIVATED CARBON FILTER					
Rate of filtration in normal working condition	[6000 to 15000 litres/hour/m^2]				
Rate of filtration adopted for design	10000	litres/hour/m^2			
	10	m^3	[safer side]		
Ultimate demand in MLD	1.346577				
Hours of pumping adopted	20				
Actual ultimate discharge in MLD	1.615892				
Allowance for wastage in %	1				
Design discharge adopted in MLD	1.632				
Area required in m^2	6.80				
Required diameter in m	2.94	[range is 0.30 to 2.75 m]			
Fix diameter in m	3	3000	mm		
Maximum pressure in kg/cm^2	4	0.408	Mpa		

Factored stress in Mpa	0.82				
Safe stress in steel in kg/cm^2					
	165	[mild steel]		minimum	
Safe stress for MS adopted in design in Mpa	110.55				
Required thickness for the cylindrical shell in mm	pd/2μ				
	11.07	fix	12	mm	
Required thickness for hemispherical part in mm	pd/4μ				
	5.53	fix	12	mm	
For the condition of no distortion at the junction, pd/4tc E [2-(1/m)] = pd/4ts E [1-(1/m)]					
ts/tc = 0.43 for 1/m = 0.25					
Then, thickness of spherical shell required in mm			5.16	ok	
For the condition of same maximum stress in cylindrical and hemispherical parts, pd/2tc = pd/4tc, ts/tc = 0.5					
Then, thickness of spherical shell required in mm			6	ok	
Hoop stress in cylindrical parts in Mpa			50.9684	ok	
Hoop stress in spherical parts in Mpa			25.4842	ok	
Hoop stress in spherical parts in Mpa if same thickness throughout			25.48	ok	
If top and bottom portions are not spherical, then provide parabolic dome of MS with same thickness of cylindrical portion					
Rise of the dome in mm			750		
Then, meridional stress in Mpa			32.81	ok	

4.9 SLUDGE DISPOSAL PLAN

Sludge is generated in primary, secondary and advanced wastewater treatment processes. Primary sludge consists of settleable solids carried in the raw wastewater. Secondary sludge consists of biological solids as well as additional settleable solids. In the treatment system, facility for thickening and dewatering of sludge is provided even though it is not essential for small STPs. This is to stabilize the sludge and generate an efficient sludge disposal mechanism. thickening is a procedure used to increase the solids content of sludge by removing a portion of the liquid fraction. Thickening is generally accomplished by physical means like gravity settling and it is adopted in the present system. Whereas centrifuges are used to thicken and dewater sludges. Thickening by centrifugation involves the settling of sludge particles under the influence of centrifugal forces. The design of various components of sludge handling units are illustrates as follows:

Sludge Sump						
Average flow	1346.58	m^3/day				
TSS	400	mg/l				
BOD	263.13	mg/l				
Assumed TSS Sludge	30%					
Assumed BOD Sludge	35%					

Sludge generated-TSS	161.6	kg/day				
Sludge generated-BOD	124.0	kg/day				
Total sludge	285.60	kg/day				
% sludge with 1.02 specific gravity	10%					
Sludge volume per day	28.00	m^3/day				
	1.17	m^3/hour				
Assumed HRT	3	hours	freeboard	0.5	m	
Volume of tank	3.50	m^3	slab thickness	0.3	m	
Assumed SWD	1.5	m	offset to wall	0.3	m	
Area of the tank	2.33	m^2	wall thickness	0.3	m	
Diameter of circular tank	1.72	m	fix	1.75	m	
Actual capacity provided	3.61	m^3		area in m^2		2.95
Pump for Sludge transfer to Thickener						
Number of pumps	1.00	W	1	SB		
Specific gravity of liquid	1.03					
Type of pump set	submersible centrifugal sewage transfer-non clog					
Working hours	5.00	hours				
Discharge required	5.60	m^3/hour	0.001556	m^3/sec		
Required head	15.00	m				
Velocity in sludge transfer pipe adopted	0.70	m/sec				
Pipe diameter required	53.19	mm	fix	100	m m	
Efficiency	50%					
Power required	0.62	HP	fix	1.00	HP	
Energy	2.32	kwh				
Sludge Thickener						
Number of units	1					
Total sludge	285.60	kg/day				
Solids Loading Rate	40	kg/m^2/day				
Thickening area required	7.14	m^2				
Surface Loading Rate	12	m^3/m^2/day				
Thickening area required	2.33	m^2	freeboard	0.5	m	
Maximum area	7.14	m^2	slab thickness	0.35	m	
Area of distribution chamber	20%		offset to wall	0.35	m	
Total area required	8.57	m^2	wall thickness	0.3	m	
Diameter of circular tank	3.30	m	fix	3.3	m	
Thickening area available	8.55	m^2				
SWD	2	m				
Actual volume provided	17.11	m^3				
Thickened sludge consistency	3%	of total sludge volume				
Thickened sludge volume	8.57	m^3/day	area in m^2			4.60
Pump for Sludge transfer to Centrifuge						

Type of pump set	Screw pump					
Number of pumps	1.00	W	1	SB		
Volume of thickened sludge to be pumped	8.57	m^3/day				
Working hours of centrifuge	5.00	hours				
Discharge required	1.71	m^3/hour	4.8E-04	m^3/sec		
Head required	15.00	m				
Efficiency	50%					
Power required	0.190	fix	0.50	HP		
Energy	0.710	kwh				
Sludge Centrifuge and Dosing Tanks						
Number of centrifuges	1	SB	1			
Capacity of centrifuge	0.25	m^3/hour				
Poly electrolyte dozing for centrifuge & thickener	10%					
Sludge volume	285.60	kg/day				
Dose	2	kg/1000 kg				
Quantity of Poly Electrolyte	0.57	kg/day				
Concentration	0.1					
Volume of tanks @ 24 hour	0.57	m^3				
	571.21	litres				
Volume	23.80	litres/hour				
Volume required for 8 hours	0.19	m^3				
Liquid depth of tank	1	m				
Area required	0.19	m^2				
side of square tank	0.44	m	fix	0.5		

4.10 PRELIMINARY STRUCTURAL DESIGN OF COMPONENTS

For the various units of the STP, structural analysis and design have been performed in accordance with the stipulations of all relevant Indian Standard Codes of practice. For the reinforced concrete elements, special attention has been given to arrive at the preliminary dimensions to satisfy norms and conditions for the water retaining structures. For the metallic structures like pressure filter units, similar approach has been adopted. Since the units are constantly in contact with aggressive environment like sewage, non-corrosive coating for reinforcing steel and water proofing application for the inner side of reinforced concrete structures are recommended. These provisions are already given in the detailed estimates. During the execution stage, a detailed structural analysis of the components can be performed. However, the dimensions are expected to fall within the limits of the values obtained from the preliminary analysis. In the case of foundations, simple raft and beam-slab type raft is adopted for safety considerations. Since the soil nature is observed to be satisfactory to withstand medium loading conditions, deep foundations are not suggested. Soil analysis reports available for the locality has been examined to arrive at a decision. However, during the execution stage, detailed soil investigations can

be performed. Cover for the reinforced concrete elements is to be given in accordance with the exposure conditions given in the IS 456 Code of practice. Even though, most of the components are designed as reinforced concrete, innovative materials with high strength to weight ratio like Fibre Reinforce Polymers (FRPs) can also be tried after performing detailed structural analysis.

Manholes and pipelines are to be checked for external traffic loads pertaining to the characteristics of each road and soil conditions. Since the accurate data of this will be obtained during the execution stage of the project, the detailed structural analysis of the pipelines and manholes will be required to be performed later and the changes are to be incorporated accordingly.

4.11 SITE PROPOSED FOR COLLECTION WELLS AND STP

The tentative sites proposed for the collection wells and sewage treatment plant is given as follows:

Sl. No.	Type of structure	Location	Coordinates as per GPS	Extent of land
1	Collection well – 1	Near Kummayachira	10.66490908 Lat, 76.24553288 Long	0.014 Hectare
2	Collection well – 2	Near Kummayachira	10.66512067 Lat, 76.24575758 Long	0.014 Hectare
3	STP	Near ground at EK Nayanar road	10.66530753 Lat, 76.2439404 Long	0.1618 Hectare

Table 13 Site proposed for collection wells and STP

The soil conditions are observed to be medium to hard soil and at some locations in lateritic nature. However, during execution of the project detailed soil investigations are to be performed. Any changes are the site locations must be incorporated in the hydraulic models and analysed for successful routing subsequently.

4.12 DIMENSIONS AND MATERIAL OF CONSTRUCTION OF STP UNITS

The details of functional sizing and materials of construction of Sewage Treatment Plant (STP) units are illustrated below:

SIZING OF STP UNITS						
Sl. No.	COMPONENT	SIZING (m)			Nos.	TYPE OF CONSTRUCTION
	CIVIL CONSTRUCTION UNITS					
		L	B	H		
1	Receiving Chamber-STP	2.5	1.5	2.95	1	RCC
2	Receiving Chamber-CTU	1	0.5	1.85	1	RCC
3	Oil and Grease Trap-STP	2.8	1.5	3.25	1	RCC
4	Oil and Grease Trap-CTU	1.5	0.75	2.25	1	RCC
5	Manual Coarse Screen Channel-STP	2.2	0.75	1.2	1	RCC

6	Manual Coarse Screen Channel-CTU	2.5	0.6	1.5	1	RCC
7	Manual Fine Screen Channel-STP	2.5	0.75	1.5	1	RCC
8	Grit Separator	2.5	2	3.30	1	RCC
9	Equalisation Tank	10	10	4.10	1	RCC
10	Moving Bed Biofilm Reactor-1	7.4	7.4	4.10	1	RCC
11	Moving Bed Biofilm Reactor-2	8.45	8.45	4.10	1	RCC
12	Moving Bed Biofilm Reactor-3	5.4	5.4	4.10	1	RCC
13	Moving Bed Biofilm Reactor-4	3.35	3.35	4.10	1	RCC
14	Clarifier with Plate Settler	4.2	4.2	4.8	1	RCC
15	Filter feed tank	3.1	3.1	2.35	1	RCC
16	Sludge Sump	Dia	1.75	3.1	1	RCC
17	Sludge Thickener	Dia	3.3	2.5	1	RCC
18	Chlorine Contact Tank	3.75	3.75	2.35	1	RCC
19	Treated Water Tank	4.75	4.75	2.85	1	RCC
20	Pump house (fabricated)	1.5	1.5	4	1	Steel Truss and Bricks (common)
21	Sludge Yard	2	2		1	Steel Truss and Bricks (common)
22	Centrifuge Shed	1	1		1	Steel Truss and Bricks (common)
23	Control Room				1	Steel Truss and Bricks (common)
24	Generator Basement	1.5	1		1	RCC
25	Alum solution tank	0.6	0.6	1	2	FRP/HDPE
26	Lime solution tank	0.6	0.6	1	2	FRP/HDPE
27	Hypo dosing tank	0.6	0.6	1	2	FRP/HDPE
28	Control Room					Common Space
29	Office					Common Space
SIZING OF STP UNITS						
Sl. No.	COMPONENT	Details			Nos.	TYPE OF CONSTRUCTION
	ELECTRO-MECHANICAL UNITS					
1	Sewage transfer pump to MBBR	7.5	HP		2	Submersible Centrifugal
2	Manual Coarse Screen-STP	20	mm	opening	1	SS 304
3	Manual Coarse Screen-CTU	20	mm	opening	1	SS 304
4	Manual Fine Screen-STP	6	mm	opening	1	SS 304
5	Air Grid and Diffused aeration system for ET, MBBR Tanks and Sludge Tank			As per design		PVC
6	MBBR carrier			As per design		PVC/HDPE
7	Air Blowers	2800.82	m^3/hour		2	Positive displacement
8	Plate Settlers			As per design		PVC
9	Sludge transfer pump to thickener	1.00	HP		2	Submersible Centrifugal
10	Sludge transfer pump to centrifuge	0.50	HP		2	Screw type pump

11	Sludge Centrifuge	0.25	m^3/hour		2	
12	Pump for clarified water to PSF and ACF	17.50	HP		2.00	Submersible Centrifugal
13	Pressure Sand Filter (Dual media)	Dia	2.7	m	1	MS with all specials
14	Activated Carbon Filter	Dia	3	m	1	MS with all specials
15	Jetting/Cleaning machine				1	High pressure pump
16	Generator				1	Diesel type automatic switch over
17	Chlorinator					Electro type of similar
18	IoT based sensors					Discharge, BOD, DO, TSS, ph sensors

Table 14 Dimensions and material of construction of sewage treatment system

CHAPTER 5

DETAILED ESTIMATES

5.1 GENERAL

The detailed estimate for the STP components is prepared in accordance with the Delhi Schedule of Rates (DSR) 2018 provisions after applying District Cost Index. For certain items, market rates are adopted. For simplicity and rapid work plan, the dimensions of the design of unit operations, chemical and biological process and structural dimensions of components are given as the input values for the data spread sheet of detailed estimate.

5.2 DETAILED ESTIMATE OF COMPONENTS

The detailed estimates have been divided into four sections: a] civil construction b] mechanical works c] electrical and instrumentation works d] operation and maintenance. In following sections, the detailed estimates are illustrated.

5.3 RECEIVING CHAMBER

RECEIVING CHAMBER										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead up to 50 m and lift up to 1.5 m, as directed by Engineer-in-charge								
		For receiving chamber-STP	1	3.6	2.6	3.4	31.82	m^3		
		For receiving chamber-CTU	1	1.55	1.6	2.15	5.33	m^3		
		Total					37.15	m^3		
		Say		37.15	m^3		@	Rs	213.85	7944.9
		GST component						Rs	38.96	1447.69
2	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		For receiving chamber-STP	1	3.6	2.6	0.15	1.4	m^3		
		For receiving chamber-CTU	1	1.55	1.6	0.15	0.37	m^3		
		Total					1.77	m^3		
		Say		1.77	m^3		@	Rs	7202.3	12748.15

		GST component						Rs	1312.38	2322.92
3	5.37.1 +5.34. 1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/^{3}.Excess/less cement used as per design mix is payable/recoverable separately).								
		For receiving chamber- STP								
		Bottom slab	1	3.60	2.60	0.3	2.81	m^3		
		Long wall	2	3.00	0.25	2.95	4.43	m^3		
		Short wall	2	1.50	0.25	2.95	2.21	m^3		
		For receiving chamber- CTU								
		Bottom slab	1	1.55	1.60	0.30	0.74	m^3		
		Long wall	2	1.50	0.25	1.85	1.39	m^3		
		Short wall	2	0.50	0.25	1.85	0.46	m^3		
		Total					12.04	m^3		
		Say		12.0	m^3		@	Rs	9956.30	119873.9
		GST component						Rs	1814.20	21843.02
4	5.37.1	Providing and laying in position ready mixed M-25 grade concrete for reinforced cement concrete work, using cement content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/ cum. Excess/less cement used as per design mix is payable/recoverable separately).								
		Top slab- STP	1	3	2	0.15	0.9	m^3		
		Top slab- CTU	1	1.25	1	0.15	0.19	m^3		
		Total					1.09	m^3		
		Deduction								
		Manhole	2	0.6	0.45	0.15	0.08	m^3		
		Total					0.08	m^3		
		Total after deduction					1.01	m^3		
		Say		1.01	m^3		@	Rs	9874.30	9973.04

		GST component						Rs	1799.26	1817.25
5	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.3	1		12.04	m^3	120	kg/m^3	1444.8	kg
		Quantity as per item No.4	1		1.01	m^3	100	kg/m^3	101	kg
		Total							1545.8	kg
		Say		1546	kg		@	Rs	98.17	151752.7
		GST component						Rs	17.89	27651.87
6	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								
		Quantity as per item No.3	1		12.04	m^3	340	kg/m^3	4093.6	kg
		Quantity as per item No.4	1		1.01	m^3	330	kg/m^3	333.3	kg
		Total							4426.9	kg
		Say		88.5	bags		@	Rs	66.4858	5886.53
		GST component						Rs	12.11	1072.62
7	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								
		Bottom slab-STP	1	6.2		0.3	1.86	m^2		
		Bottom slab-CTU	1	4.7		0.3	1.41	m^2		
		Total					3.27	m^2		
		Say		3.27	m^2		@	Rs	334.898	1095.12
		GST component						Rs	61.02	199.55
8	5.9.2	Centering and shuttering including strutting, propping etc. and removal of form for :Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.								
		For walls outside-STP	2	5		2.95	29.50	m^2		
		For walls inside-STP	2	4		2.95	23.60	m^2		
		For walls outside-CTU	1	3.5		1.85	6.48	m^2		
		For walls inside-CTU	1	2.5		1.85	4.63	m^2		
		Total					64.20	m^2		
		Say		64.2	m^2		@	Rs	716.354	45989.96
		GST component						Rs	130.53	8380.13

9	5.9.3	Centering and shuttering including strutting, propping etc. and removal of form for: Suspended floors, roofs, landings, balconies and access platform								
		Top slab-STP	2	5		0.15	1.50	m^2		
		Bottom portion-STP	1	2.5	1.5		3.75	m^2		
		Top slab-CTU	1	3.5		0.15	0.53	m^2		
		Bottom portion-CTU	1	1	0.5		0.50	m^2		
		Total					6.28	m^2		
		Say		6.28	m^2		@	Rs	814.819	5112.99
		GST component						Rs	148.473	931.67
10	2.25	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift up to 1.5 m.								
		Quantity as per item 1	1				37.15	m^3		
		Deductions								
		PCC	1				1.77	m^3		
		Bottom slab	1				3.55	m^3		
		Receiving chamber	1				8.49	m^3		
		Top slab	1				1.09	m^3		
		Quantity after deductions	1				22.25	m^3		
		Say		22.25	m^3		@	Rs	258.2427	5745.9
		GST component						Rs	47.056103	1047
11	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm								
		Inside of walls-STP	2	4		2.95	23.60	m^2		
		Inside of walls-CTU	1	2.5		1.85	4.63	m^2		
		Total					28.23	m^2		
		Say		28.23	m^2		@	Rs	569.568	16076.07

		GST component						Rs	103.78	2929.33
12	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.								
		Bottom slab inside-STP	1	2.5	1.5		3.75	m^2		
		Bottom slab inside-CTU	1	1	0.5		0.5	m^2		
		Total					4.25	m^2		
		Say		4.25	m^2		@	Rs	439.006	1865.78
		GST component						Rs	79.99	339.98
13	13.7.1	12 mm cement plaster finished with a floating coat of neat cement :1:3 (1 cement : 3 fine sand)								
		Inside of walls-STP	2	4		2.95	23.6	m^2		
		Base slab inside-STP	1	2.5	1.5		3.75	m^2		
		Top slab bottom-STP	1	2.5	1.5		3.75	m^2		
		Inside of walls-CTU	2	2		1.85	7.4	m^2		
		Base slab inside-CTU	1	1	0.5		0.5	m^2		
		Top slab bottom-CTU	1	1	0.5		0.5	m^2		
		Total					39.5	m^2		
		Deduction								
		Manhole	1	0.6	0.45		0.27	m^2		
		Total					0.27	m^2		
		Total after deduction					39.23	m^2		
		Say		39.23	m^2		@	Rs	439.00	17222.23
		GST component						Rs	79.99	3138.18
14	19.18.1	Supplying and fixing C.I. cover without frame for manholes :455x610 mm rectangular C.I. cover (light duty) the weight of the cover to be not less than 23 kg								
			2				2	No.		
		Say		2	No.		@	Rs	1559.27	3118.55
		GST component						Rs	284.12	568.25

15		Providing and fixing uPVC pipes & fittings including jointing of pipes with one step uPVC solvent cement , testing of joints complete as per direction of Engineer in Charge. 110mm dia 6Kgf/cm²- for vent pipe								
			1	0.45			0.45	m		
		Total					0.45	m		
		Say		0.45	m		@	Rs	1222.7289	550.23
		GST component						Rs	222.80149	100.26
		Total- Receiving Chamber								₹ 4,04,956
		GST component								₹ 73,790

5.4 OIL AND GREASE TRAP

OIL AND GREASE TRAP										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead up to 50 m and lift up to 1.5 m, as directed by Engineer-in-charge								
		For oil and grease trap-STP	1	3.7	2.4	3.55	31.52	m^3		
		For oil and grease trap-CTU	1	2.3	1.55	2.25	8.02	m^3		
		Total					39.54	m^3		
		Say		39.54	m^3		@	Rs	213.86	8456.02
		GST component						Rs	38.97	1540.83
2	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		For oil and grease trap-STP	1	3.7	2.4	0.15	1.33	m^3		
		For oil and grease trap-CTU	1	2.3	1.55	0.15	0.53	m^3		
		Total					1.86	m^3		
		Say		1.86	m^3		@	Rs	7202.34	13396.36
		GST component						Rs	1312.39	2441.04
3	5.37.1 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete								

		work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/^{3}.Excess/less cement used as per design mix is payable/recoverable separately).								
		For oil and grease trap-STP								
		Bottom slab	1	3.70	2.40	0.35	3.11	m^3		
		Long wall	2	3.40	0.30	3.25	6.63	m^3		
		Short wall	2	1.50	0.30	3.25	2.93	m^3		
		For oil and grease trap-CTU								
		Bottom slab	1	2.30	1.55	0.30	1.07	m^3		
		Long wall	2	2.00	0.25	2.25	2.25	m^3		
		Short wall	2	0.75	0.25	2.25	0.84	m^3		
		Total					16.83	m^3		
		Say		16.83	m^3		@	Rs	9956.305	167564.62
		GST component						Rs	1814.204	30533.05
4	5.37.1	Providing and laying in position ready mixed M-25 grade concrete for reinforced cement concrete work, using cement content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/ cum.Excess/less cement used as per design mix is payable/recoverable separately).								
		Top slab-STP	1	3.4	2.1	0.15	1.07	m^3		
		Top slab-CTU	1	2.0	1.25	0.15	0.38	m^3		
		Total					1.45	m^3		
		Deduction								
		Manhole	2	0.6	0.45	0.15	0.08	m^3		
		Total					0.08	m^3		
		Total after deduction					1.37	m^3		
		Say		1.37	m^3		@	Rs	9874.30	13527.79
		GST component						Rs	1799.26	2464.99
5	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete up to plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.3	1		16.83	m^3	120	kg/ m^3	2019.6	kg

		Quantity as per item No.4	1		1.37	m^3	100	kg/ m^3	137	kg
		Total							2156.6	kg
		Say		2157	kg		@	Rs	98.17	211715.63
		GST component						Rs	17.89	38578.1
6	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								
		Quantity as per item No.3	1		16.83	m^3	340	kg/ m^3	5722.2	kg
		Quantity as per item No.4	1		1.37	m^3	330	kg/ m^3	452.1	kg
		Total							6174.3	kg
		Say		123.5	bags		@	Rs	66.49	8210.08
		GST component						Rs	12.11	1496.01
7	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								
		Bottom slab-STP	2	6.1		0.35	4.27	m^2		
		Bottom slab-CTU	2	3.85		0.30	2.31	m^2		
		Total					6.58	m^2		
		Say		6.58	m^2		@	Rs	334.9	2203.63
		GST component						Rs	61.0	401.54
8	5.9.2	Centering and shuttering including strutting, propping etc. and removal of form for :Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.								
		For walls outside-STP	2	5.5		3.25	35.75	m^2		
		For walls inside-STP	2	4.3		3.25	27.95	m^2		
		For walls outside-CTU	2	3.25		2.25	14.63	m^2		
		For walls inside-CTU	2	2.25		2.25	10.13	m^2		
		Total					88.45	m^2		
		Say		88.45	m^2		@	Rs	716.35	63361.56
		GST component						Rs	130.53	11545.53
9	5.9.3	Centering and shuttering including strutting, propping etc. and removal of form for :Suspended floors, roofs, landings, balconies and access platform								
		Top slab-STP	2	5.5		0.15	1.65	m^2		
		Bottom portion-STP	1	2.8	1.5		4.2	m^2		
		Top slab-CTU	2	3.25		0.15	0.975	m^2		
		Bottom portion-CTU	1	1.5	0.75		1.125	m^2		
		Total					7.95	m^2		

		Say		7.95	m^2		@	Rs	814.82	6477.82
		GST component						Rs	148.47	1180.37
10	2.25	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift up to 1.5 m.								
		Quantity as per item 1	1				39.54	m^3		
		Deductions								
		PCC	1				1.86	m^3		
		Bottom slab	1				4.18	m^3		
		Oil and grease trap	1				12.65	m^3		
		Top slab	1				1.45	m^3		
		Quantity after deductions	1				19.40	m^3		
		Say		19.40	m^3		@	Rs	258.24	5009.91
		GST component						Rs	47.06	912.89
11	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm								
		Inside of walls-STP	2	4.3		3.25	27.95	m^2		
		Inside of walls-CTU	2	2.25		2.25	10.13	m^2		
		Total					38.08	m^2		
		Say		38.08	m^2		@	Rs	569.57	21686.31
		GST component						Rs	103.78	3951.61

12	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.								
		Bottom slab inside-STP	1	2.8	1.5		4.2	m^2		
		Bottom slab inside-CTU	1	1.5	0.75		1.125	m^2		
		Total					5.325	m^2		
		Say		5.325	m^2		@	Rs	439.01	2337.71
		GST component						Rs	79.99	425.97
13	13.7.1	12 mm cement plaster finished with a floating coat of neat cement :1:3 (1 cement : 3 fine sand)								
		for STP								
		Inside of walls	1	8.6		3.25	27.95	m^2		
		Base slab inside	1	2.8	1.5		4.2	m^2		
		Top slab bottom	1	2.8	1.5		4.2	m^2		
		for CTU								
		Inside of walls	1	4.5		2.25	10.13	m^2		
		Base slab inside	1	1.5	0.75		1.125	m^2		
		Top slab bottom	1	1.5	0.75		1.125	m^2		
		Total					48.73	m^2		
		Deduction								
		Manhole	2	0.6	0.45		0.54	m^2		
		Total					0.54	m^2		
		Total after deduction					48.19	m^2		
		Say		48.19	m^2		@	Rs	400.74	19309.54
		GST component						Rs	73.02	3518.52
14	19.18.1	Supplying and fixing C.I. cover without frame for manholes :455x610 mm rectangular C.I. cover (light duty) the weight of the cover to be not less than 23 kg								
			1				1	No.		
		Say		2	No.		@	Rs	1559.27	3118.55

		GST component						Rs	284.13	568.25
		Total-Oil and Grease Trap								₹ 5,46,376
		GST component								₹ 99,559

5.5 GRIT CHAMBER AND SCREEN CHANNELS

GRIT SEPERATOR AND SCREEN CHANNELS										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead up to 50 m and lift up to 1.5 m, as directed by Engineer-in-charge								
		For grit separator	1	3.7	3.2	3.75	44.4	m^3		
		For screen channel-STP	2	9.7	1.75	1.65	56.02	m^3		
		For screen channel-CTU	1	3.00	1.60	1.65	7.92	m^3		
		Total					108.3	m^3		
		Say		108.3	m^3		@	Rs	213.86	23169.59
		GST component						Rs	38.97	4221.88
2	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		For grit separator	1	3.7	3.2	0.15	1.78	m^3		
		For screen channel-STP	2	9.7	1.75	0.15	5.09	m^3		
		For screen channel-CTU	1	3	1.60	1.15	5.52	m^3		
		Total					12.39	m^3		
		Say		12.39	m^3		@	Rs	7202.34	89237.04
		GST component						Rs	1312.39	16260.47
3	5.37.1 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/^{3}.Excess/less cement used as per design mix is payable/recoverable separately).								
		For grit separator								

		Bottom slab	1	3.70	3.20	0.30	3.55	m^3		
		Walls	2	5.10	0.30	3.30	10.1	m^3		
		Top slab	1	3.10	2.60	0.15	1.21	m^3		
		Total					14.86	m^3		
		Deduction								
		Manhole	1	0.6	0.45	0.15	0.04	m^3		
		Total					0.04	m^3		
		Total after deduction					14.82	m^3		
		Say		14.82	m^3		@	Rs	9956	147552.45
		GST component						Rs	1814.20	26886.5
		For screen channel								
		Bottom slab-STP	2	9.70	1.75	0.30	10.19	m^3		
		Bottom slab-CTU	1	3.00	1.60	0.30	1.44	m^3		
		Wall-STP	4	9.70	0.25	1.20	11.64	m^3		
		Wall-CTU	2	2.50	0.25	1.50	1.88	m^3		
		Top slab-STP	2	9.70	1.25	0.15	3.64	m^3		
		Top slab-CTU	1	2.50	1.10	0.15	0.41	m^3		
		Total					29.2	m^3		
		Deduction								
		Manhole	3	0.6	0.45	0.15	0.12	m^3		
		Total					0.12	m^3		
		Total after deduction					29.08	m^3		
		Say		29.08	m^3		@	Rs	9956.31	289529.36
		GST component						Rs	1814.20	52757.05
4	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.3	1		43.9	m^3	120	kg/m^3	5268	kg
		Total							5268	kg
		Say		5268	kg		@	Rs	98.17	517164.96
		GST component						Rs	17.89	94236.03
5	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								

		Quantity as per item No.3	1		43.9	m^3	340	kg/m^3	14926	kg
		Total							14926	kg
		Say		298.5	bags		@	Rs	66.49	19847.37
		GST component						Rs	12.11	3616.52
6	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								
		Bottom slab-grit separator	2	6.9		0.30	4.14	m^2		
		Bottom slab-screen channel-STP	4	9.7		0.30	11.64	m^2		
		Bottom slab-screen channel-CTU	2	2.5		0.30	1.50	m^2		
		Total					17.28	m^2		
		Say		17.28	m^2		@	Rs	334.90	5787.04
		GST component						Rs	61.02	1054.5
7	5.9.2	Centering and shuttering including strutting, propping etc. and removal of form for :Walls (any thickness) including attached pilasters, butteresses, plinth and string courses etc.								
		For walls outside-grit separator	2	5.70		3.30	37.62	m^2		
		For walls inside-grit separator	2	4.50		3.30	29.70	m^2		
		For walls outside-channel-STP	4	9.70		1.20	46.56	m^2		
		For walls inside-channel-STP	4	9.70		1.20	46.56	m^2		
		For walls outside-channel-CTU	2	2.50		1.50	7.50	m^2		
		For walls inside-channel-CTU	2	2.50		1.50	7.50	m^2		
		Total					175.44	m^2		
		Say		175.44	m^2		@	Rs	716.35	125677.24
		GST component						Rs	130.53	22900.48
8	5.9.3	Centering and shuttering including strutting, propping etc. and removal of form for :Suspended floors, roofs, landings, balconies and access platform								
		Top slab-grit separator	2	5.7		0.15	1.71	m^2		
		Bottom portion-grit separator	1	2.50	2		5.00	m^2		
		Top slab-channels-STP	4	9.70		0.15	5.82	m^2		
		Bottom portion-channels-STP	2	9.70	0.75		14.55	m^2		
		Top slab-channels-CTU	2	2.5		0.15	0.75	m^2		

		Bottom portion-channels-CTU	1	2.50	0.6		1.50	m^2		
		Total					29.33	m^2		
		Say		29.33	m^2		@	Rs	814.82	23898.66
		GST component						Rs	148.47	4354.73
9	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm								
		Inside of walls-grit separator	2	4.5		3.30	29.7	m^2		
		Inside of walls-channels-STP	4	9.7		1.20	46.56	m^2		
		Inside of walls-channels-CTU	2	2.5		1.50	7.5	m^2		
		Total					83.76	m^2		
		Say		83.76	m^2		@	Rs	569.57	47707.04
		GST component						Rs	103.78	8693.01
10	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.								
		Bottom slab inside-grit box	1	2.5	2		5.00	m^2		
		Bottom slab inside-channels-STP	2	9.7	0.75		14.55	m^2		
		Bottom slab inside-channels-CTU	1	2.5	0.6		1.50	m^2		

		Total					21.05	m^2		
		Say		21.05	m^2		@	Rs	439.01	9241.09
		GST component						Rs	79.99	1683.88
11	13.7.1	12 mm cement plaster finished with a floating coat of neat cement :1:3 (1 cement : 3 fine sand)								
		Inside of walls-grit separator	2	4.5		3.30	29.7	m^2		
		Base slab inside-grit separator	1	2.5	2		5.00	m^2		
		Top slab bottom-grit box	1	2.5	2		5.00	m^2		
		Inside of walls-channels-STP	4	9.7		1.20	46.56	m^2		
		Base slab inside-channels-STP	2	9.7	0.75		14.55	m^2		
		Top slab bottom-channels-STP	2	9.7	0.75		14.55	m^2		
		Inside of walls-channels-CTU	2	2.5		1.50	7.5	m^2		
		Base slab inside-channels-CTU	1	2.5	0.6		1.5	m^2		
		Top slab bottom-channels-CTU	1	2.5	0.6		1.5	m^2		
		Total					125.86	m^2		
		Deduction								
		Manhole	2	0.6	0.45		0.54	m^2		
		Total					0.54	m^2		
		Total after deduction					125.32	m^2		
		Say		125.32	m^2		@	Rs	400.74	50220.44
		GST component						Rs	73.02	9151
12	2.25	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m.								
		Quantity as per item 1	1				108.3	m3		
		Deductions								
		PCC	1				12.39	m3		
		Bottom slab	1				15.18	m3		
		Tank/channel	1				37.32	m3		
		Top slab	1				5.26	m3		
		Quantity after deductions	1				38.2	m3		
		Say		38.2	m^3		@	Rs	258.24	9861.51
		GST component						Rs	47.06	1796.93

13	19.18.1	Supplying and fixing C.I. cover without frame for manholes :455x610 mm rectangular C.I. cover (light duty) the weight of the cover to be not less than 23 kg								
			3				3	No.		
		Say		3	No.		@	Rs	1559.27	4677.82
		GST component						Rs	284.13	852.38
14		Providing and fixing uPVC pipes & fittings including jointing of pipes with one step uPVC solvent cement, testing of joints complete as per direction of Engineer in Charge. 110mm dia 6Kgf/cm²- for vent pipe								
			1	0.45			0.45	m		
		Total					0.45	m		
		Say		0.45	m		@	Rs	1222.73	550.23
		GST component						Rs	222.80	100.26
		Total-Grit Separator and Screen Channel								₹ 13,64,122
		GST component								₹ 2,48,566

5.6 EQUALISATION TANK

EQUALISATION TANK										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead up to 50 m and lift up to 1.5 m, as directed by Engineer-in-charge								
		Shape of tank	1	(put 1 for rectangular and 2 for circular)						
		Equalisation tank	1	11.50	11.5	4.95	654.6	m^3		
		Total					654.6	m^3		
		Say		654.6	m^3		@	Rs	213.86	140001.31
		GST component						Rs	38.97	25510.56
2	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		Equalisation tank	1	11.5	11.5	0.15	19.84	m^3		
		Total					19.84	m^3		
		Say		19.84	m^3		@	Rs	7202	142894.5
		GST component						Rs	1312	26037.75

3	5.37.1 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/^{3}.Excess/less cement used as per design mix is payable/recoverable separately).									
		For equalisation tank								
		Bottom slab	1	11.50	11.50	0.45	59.51	m^3		
		Long wall	2	10.60	0.30	4.35	27.67	m^3		
		Short wall	2	10.00	0.30	4.35	26.1	m^3		
		Top slab	1	10.60	10.60	0.15	16.85	m^3		
		Total					130.1	m^3		
		Deduction								
		Manhole	1	0.6	0.45	0.15	0.04	m^3		
		Total					0.04	m^3		
		Total after deduction					130.1	m^3		
		Say		130.09	m^3		@	Rs	9956	1295215.77
		GST component						Rs	1814.20	236009.79
4	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.3	1		130.09	m^3	120	kg/m^3	15610.8	kg
		Total							15610.8	kg
		Say		15611	kg		@	Rs	98.17	1532528.23
		GST component						Rs	17.89	279252.06
5	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								
		Quantity as per item No.3	1		130.09	m^3	340	kg/m^3	44230.6	kg
		Total							44230.6	kg
		Say		884.6	bags		@	Rs	66.49	58814.21
		GST component						Rs	12.11	10716.92
6	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								

		Bottom slab	2	23		0.45	20.70	m^2		
		Total					20.70	m^2		
		Say		20.70	m^2		@	Rs	334.90	6932.40
		GST component						Rs	61.02	1263.2
7	5.9.2	Centering and shuttering including strutting, propping etc. and removal of form for :Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.								
		For walls outside	2	21.20		4.35	184.44	m^2		
		For walls inside	2	20.00		4.35	174.00	m^2		
		Total					358.44	m^2		
		Say		358.44	m^2		@	Rs	716.35	256770.13
		GST component						Rs	130.53	46787.78
8	5.9.3	Centering and shuttering including strutting, propping etc. and removal of form for :Suspended floors, roofs, landings, balconies and access platform								
		Top slab	1	21.2		0.15	3.18	m^2		
		Bottom portion	1	10.00	10		100.00	m^2		
		Total					103.18	m^2		
		Say		103.18	m^2		@	Rs	814.82	84073.08
		GST component						Rs	148.47	15319.51
9	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm								
		Inside of walls	2	20		4.35	174	m^2		
		Total					174	m^2		
		Say		174	m^2		@	Rs	569.57	99104.88
		GST component						Rs	103.78	18058.55

10	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.								
		Bottom slab inside	1	10	10		100	m^2		
		Total					100	m^2		
		Say		100	m^2		@	Rs	439.01	43900.67
		GST component						Rs	79.99	7999.43
11	13.7.1	12 mm cement plaster finished with a floating coat of neat cement :1:3 (1 cement : 3 fine sand)								
		Inside of walls	2	20.0		4.35	174	m^2		
		Base slab inside	1	10	10		100	m^2		
		Top slab bottom	1	10	10		100	m^2		
		Total					374	m^2		
		Deduction								
		Manhole	1	0.6	0.45		0.27	m^2		
		Total					0.27	m^2		
		Total after deduction					373.7	m^2		
		Say		373.7	m^2		@	Rs	400.74	149767.68
		GST component						Rs	73.02	27290.16
12	2.25	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift up to 1.5 m.								
		Quantity as per item 1	1				654.6	m3		
		Deductions								
		PCC	1				19.84	m3		
		Bottom slab	1				59.51	m3		
		Tank	1				488.77	m3		
		Top slab	1				16.85	m3		
		Quantity after deductions	1				69.7	m3		
		Say		69.7	m^3		@	Rs	258.24	17992.8
		GST component						Rs	47.06	3278.59

13	19.18.1	Supplying and fixing C.I. cover without frame for manholes :455x610 mm rectangular C.I. cover (light duty) the weight of the cover to be not less than 23 kg								
			1				1	No.		
		Say		1	No.		@	Rs	1559.27	1559.27
		GST component						Rs	284.13	284.13
14		Providing and fixing uPVC pipes & fittings including jointing of pipes with one step uPVC solvent cement, testing of joints complete as per direction of Engineer in Charge. 110mm dia 6Kgf/cm²- for vent pipe								
			1	0.45			0.45	m		
		Total					0.45	m		
		Say		0.45	m		@	Rs	1222.73	550.23
		GST component						Rs	222.80	100.26
		Total Equalisation Tank								₹ 38,30,105
		GST component								₹ 6,97,909

5.7 DILUTION TANK

DILUTION TANK FOR CO-TREATMENT-rectangular										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead up to 50 m and lift up to 1.5 m, as directed by Engineer-in-charge								
		Dilution tank	1	7.50	5.50	4.10	169.1	m^3		
		Total					169.1	m^3		
		Say		169.1	m^3		@	Rs	213.86	36170.14
		GST component						Rs	38.97	6590.8
2	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		Dilution tank	1	7.50	5.50	0.15	6.19	m^3		
		Total					6.19	m^3		
		Say		6.19	m^3		@	Rs	7202.34	44582.51
		GST component						Rs	1312.39	8123.67

3	5.37.1 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/^{3}.Excess/less cement used as per design mix is payable/recoverable separately).									
		Dilution tank								
		Bottom slab	1	7.50	5.50	0.45	18.56	m^3		
		Long wall	2	6.60	0.30	3.35	13.27	m^3		
		Short wall	2	4.00	0.30	3.35	8.04	m^3		
		Top slab	1	6.60	4.60	0.15	4.55	m^3		
		Total					44.42	m^3		
		Deduction								
		Manhole	1	0.6	0.45	0.15	0.04	m^3		
		Total					0.04	m^3		
		Total after deduction					44.38	m^3		
		Say		44.38	m^3		@	Rs	9956.31	441860.83
		GST component						Rs	1814.20	80514.37
4	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.3	1		44.38	m^3	120	kg/m^3	5325.6	kg
		Total							5325.6	kg
		Say		5326	kg		@	Rs	98.17	522819.61
		GST component						Rs	17.89	95266.4
5	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								
		Quantity as per item No.3	1		44.38	m^3	340	kg/m^3	15089.2	kg
		Total							15089.2	kg
		Say		301.8	bags		@	Rs	66.49	20064.38
		GST component						Rs	12.11	3656.06
6	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								
		Bottom slab	2	13.00		0.45	11.70	m^2		
		Total					11.70	m^2		

		Say		11.70	m^2		@	Rs	334.90	3918.31
		GST component						Rs	61.02	713.98
7	5.9.2	Centering and shuttering including strutting, propping etc. and removal of form for :Walls (any thickness) including attached pilasters, butteresses, plinth and string courses etc.								
		For walls outside	2	11.20		3.35	75.04	m^2		
		For walls inside	2	10.00		3.35	67.00	m^2		
		Total					142.04	m^2		
		Say		142.04	m^2		@	Rs	716.35	101751
		GST component						Rs	130.53	18540.72
8	5.9.3	Centering and shuttering including strutting, propping etc. and removal of form for: Suspended floors, roofs, landings, balconies and access platform								
		Top slab	1	11.2		0.15	1.68	m^2		
		Bottom portion	1	6.00	4.00		24.00	m^2		
		Total					25.68	m^2		
		Say		25.68	m^2		@	Rs	814.82	20924.56
		GST component						Rs	148.47	3812.8
9	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm								
		Inside of walls	2	10.00		3.35	67	m^2		
		Total					67	m^2		
		Say		67	m^2		@	Rs	569.57	38161.08
		GST component						Rs	103.78	6953.58

10	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.								
		Bottom slab inside	1	6.00	4.00		24	m^2		
		Total					24	m^2		
		Say		24	m^2		@	Rs	439.01	10536.16
		GST component						Rs	79.99	1919.86
11	13.7.1	12 mm cement plaster finished with a floating coat of neat cement :1:3 (1 cement : 3 fine sand)								
		Inside of walls	2	10.0		3.35	67	m^2		
		Base slab inside	1	6.00	4.00		24	m^2		
		Top slab bottom	1	6	4		24	m^2		
		Total					115	m^2		
		Deduction								
		Manhole	1	0.6	0.45		0.27	m^2		
		Total					0.27	m^2		
		Total after deduction					114.7	m^2		
		Say		114.7	m^2		@	Rs	400.74	45976.63
		GST component						Rs	73.02	8377.7
12	2.25	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m.								
		Quantity as per item 1	1				169.1	m3		
		Deductions								
		PCC	1				6.19	m3		
		Bottom slab	1				18.56	m3		
		Tank	1				101.71	m3		
		Top slab	1				4.55	m3		
		Quantity after deductions	1				38.1	m3		
		Say		38.1	m^3		@	Rs	258.24	9845.24
		GST component						Rs	47.06	1793.97
13	19.18.1	Supplying and fixing C.I. cover without frame for manholes :455x610 mm rectangular C.I. cover (light duty) the weight of the cover to be not less than 23 kg								
			1				1	No.		
		Say		1	No.		@	Rs	1559.27	1559.27

		GST component						Rs	284.13	284.13
14		Providing and fixing uPVC pipes & fittings including jointing of pipes with one step uPVC solvent cement, testing of joints complete as per direction of Engineer in Charge. 110mm dia 6Kgf/cm²- for vent pipe								
			1	0.45			0.45	m		
		Total					0.45	m		
		Say		0.45	m		@	Rs	1222.73	550.23
		GST component						Rs	222.80	100.26
		Total Dilution Tank								₹ 12,98,720
		GST component								₹ 2,36,648

5.8 MBBR TANK FOR BOD REMOVAL

MOVING BED BIOFILM REACTOR TANK-BOD REMOVAL										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
		Shape of tank	1	(put 1 for rectangular and 2 for circular)						
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead up to 50 m and lift upto 1.5 m, as directed by Engineer-in-charge								
		MBBR Tank-base	1	8.90	8.90	0.90	71.29	m^3		
		Total					71.29	m^3		
		Say		71.29	m^3		@	Rs	213.86	15246.08
		GST component						Rs	38.97	2778.09
2	7.1.1	Random rubble masonry in hard stone in foundation and plinth including levelling up with cement concrete 1:6:12 up to plinth level with cement mortar 1:6								
		MBBR Tank-base	1	8.90	8.9	0.90	71.29	m^3		
		Total					71.29	m^3		
		Say		71.29	m^3		@	Rs	7196.2	513019.24
		GST component						Rs	1311.3	93480.61
3	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level: 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		MBBR tank-base	1	8.90	8.9	0.15	11.88	m^3		
		Total					11.88	m^3		
		Say		11.88	m^3		@	Rs	7202.34	85563.84
		GST component						Rs	1312.39	15591.15

4	5.37.1 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/^{3}.Excess/less cement used as per design mix is payable/recoverable separately).									
		Base slab	1	8.90	8.90	0.35	27.72	m^3		
		Tank walls	2	15.40	0.30	4.10	37.88	m^3		
		Total					65.61	m^3		
		Say		65.61	m^3		@	Rs	9956.31	653208.31
		GST component						Rs	1814.20	119025.39
5	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete up to plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.2	1		65.61	m^3	120	kg/m^3	7872.9	kg
		Total							7872.9	kg
		Say		7873	kg		@	Rs	98.17	772890.66
		GST component						Rs	17.89	140833.5
6	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								
		Quantity as per item No.2	1		65.61	m^3	340	kg/m^3	22306.55	kg
		Total							22306.55	kg
		Say		446.1	bags		@	Rs	66.49	29661.41
		GST component						Rs	12.11	5404.8
7	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								
		Bottom slab	2	17.80		0.35	12.46	m^2		
		Total					12.46	m^2		
		Say		12.46	m^2		@	Rs	334.90	4172.83
		GST component						Rs	61.02	760.36
8	5.9.2	Centering and shuttering including strutting, propping etc. and removal of form for :Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.								
		For walls outside	2	16.00		4.10	131.20	m^2		

		For walls inside	2	14.80		4.10	121.46	m^2		
		Total					252.56	m^2		
		Say		252.56	m^2		@	Rs	716.35	180922.51
		GST component						Rs	130.53	32967.08
9	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm									
		Inside of walls	2	14.80		4.10	121.36	m^2		
		Total					121.36	m^2		
		Say		121.36	m^2		@	Rs	569.57	69122.81
		GST component						Rs	103.78	12595.32
10	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.									
		Bottom slab inside	1	7.40	7.4		54.76	m^2		
		Total					54.76	m^2		
		Say		54.76	m^2		@	Rs	439.01	24040.01
		GST component						Rs	79.99	4380.49
11	13.7.1	12 mm cement plaster finished with a floating coat of neat cement :1:3 (1 cement : 3 fine sand)								
		Inside of walls	2	14.80		4.10	121.36	m^2		
		Base slab inside	1	7.40	7.4		54.76	m^2		

		Total					176.12	m^2		
		Say		176.12	m^2		@	Rs	400.74	70577.91
		GST component						Rs	73.02	12860.47
		Total-MBBR Tank-1								₹ 24,18,426
		GST component								₹ 4,40,677

5.9 MBBR TANK FOR NITRIFICATION

MOVING BED BIOFILM REACTOR TANK- NITRIFICATION										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
		Shape of tank	1	(put 1 for rectangular and 2 for circular)						
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead up to 50 m and lift up to 1.5 m, as directed by Engineer-in-charge								
		MBBR Tank-base	1	9.95	9.95	0.65	64.35	m^3		
		Total					64.35	m^3		
		Say		64.35	m^3		@	Rs	213.86	13761.89
		GST component						Rs	38.97	2507.64
2	7.1.1	Random rubble masonry in hard stone in foundation and plinth including levelling up with cement concrete 1:6:12 up to plinth level with cement mortar 1:6								
		MBBR Tank-base	1	9.95	9.95	0.65	64.35	m^3		
		Total					64.35	m^3		
		Say		64.35	m^3		@	Rs	7196.2	463077.4
		GST component						Rs	1311.3	84380.38
3	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		MBBR tank-base	1	9.95	9.95	0.15	14.85	m^3		
		Total					14.85	m^3		
		Say		14.85	m^3		@	Rs	7202.34	106954.8
		GST component						Rs	1312.39	19488.94

4	5.37.1 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/^{3}.Excess/less cement used as per design mix is payable/recoverable separately).									
		Base slab	1	9.95	9.95	0.35	34.65	m^3		
		Tank walls	2	17.50	0.30	4.10	43.05	m^3		
		Total					77.70	m^3		
		Say		77.70	m^3		@	Rs	9956.31	773613.64
		GST component						Rs	1814.20	140965.24
5	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.2	1		77.70	m^3	120	kg/m^3	9324.105	kg
		Total							9324.105	kg
		Say		2738	kg		@	Rs	98.17	268792.26
		GST component						Rs	17.89	48978.41
6	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								
		Quantity as per item No.2	1		77.70	m^3	340	kg/m^3	26418.29	kg
		Total							26418.29	kg
		Say		528.37	bags		@	Rs	66.49	35128.88
		GST component						Rs	12.11	6401.06
7	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								
		Bottom slab	2	19.90		0.35	13.93	m^2		
		Total					13.93	m^2		
		Say		13.93	m^2		@	Rs	334.90	4665.13
		GST component						Rs	61.02	850.06
8	5.9.2	Centering and shuttering including strutting, propping etc. and removal of form for :Walls (any thickness) including attached pilasters, butteresses, plinth and string courses etc.								

		For walls outside	2	18.10		4.10	148.42	m^2		
		For walls inside	2	16.90		4.10	138.6	m^2		
		Total					287.00	m^2		
		Say		287.00	m^2		@	Rs	716.35	205593.76
		GST component						Rs	130.53	37462.59
9	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm									
		Inside of walls	2	16.90		4.10	138.58	m^2		
		Total					138.58	m^2		
		Say		138.58	m^2		@	Rs	569.57	78930.77
		GST component						Rs	103.78	14382.5
10	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.									
		Bottom slab inside	1	8.45	8.45		71.40	m^2		
		Total					71.40	m^2		
		Say		71.40	m^2		@	Rs	439.01	31346.18
		GST component						Rs	79.99	5711.79
11	13.7.1	12 mm cement plaster finished with a floating coat of neat cement :1:3 (1 cement : 3 fine sand)								
		Inside of walls	2	16.90		4.10	138.6	m^2		

		Base slab inside	1	8.45	8.45		71.40	m^2		
		Total					210	m^2		
		Say		210	m^2		@	Rs	400.74	84147.89
		GST component						Rs	73.02	15333.14
		Total-MBBR Tank-2								₹ 20,66,013
		GST component								₹ 3,76,462

5.10 MBBR TANK FOR DE-NITRIFICATION

MOVING BED BIOFILM REACTOR TANK- POST ANOXIC DE-NITRIFICATION										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
		Shape of tank	1	(put 1 for rectangular and 2 for circular)						
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead up to 50 m and lift up to 1.5 m, as directed by Engineer-in-charge								
		MBBR Tank-base	1	6.90	6.9	0.65	30.95	m^3		
		Total					30.95	m^3		
		Say		30.95	m^3		@	Rs	213.86	6618.97
		GST component						Rs	38.97	1206.09
2	7.1.1	Random rubble masonry in hard stone in foundation and plinth including levelling up with cement concrete 1:6:12 up to plinth level with cement mortar 1:6								
		MBBR Tank-base	1	6.90	6.9	0.65	30.95	m^3		
		Total					30.95	m^3		
		Say		30.95	m^3		@	Rs	7196.2	222723.32
		GST component						Rs	1311.3	40583.88
3	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		MBBR tank-base	1	6.9	6.9	0.15	7.14	m^3		
		Total					7.14	m^3		
		Say		7.14	m^3		@	Rs	7202.34	51424.73
		GST component						Rs	1312.39	9370.44

4	5.37.1 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/^{3}.Excess/less cement used as per design mix is payable/recoverable separately).								
		Base slab	1	6.9	6.9	0.35	16.66	m^3		
		Cover slab with central beam	1	6.00	6.00	0.15	5.40	m^3		
		Central beams of cover slab	2	5.4	0.3	0.3	0.97	m^3		
		Tank walls	2	11.40	0.30	4.10	28.04	m^3		
		Total					51.08	m^3		
		Say		51.08	m^3		@	Rs	9956.31	508563.1
		GST component						Rs	1814.20	92668.63
5	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete up to plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.2	1		51.08	m^3	120	kg/m^3	6129.54	kg
		Total							6129.54	kg
		Say		2738	kg		@	Rs	98.17	268792.26
		GST component						Rs	17.89	48978.41
6	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								
		Quantity as per item No.2	1		51.08	m^3	340	kg/m^3	17367.03	kg
		Total							17367.03	kg
		Say		347.34	bags		@	Rs	66.49	23093.25
		GST component						Rs	12.11	4207.97
7	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								
		Bottom slab	2	13.80		0.35	9.66	m^2		
		Total					9.66	m^2		
		Say		9.66	m^2		@	Rs	334.90	3235.12
		GST component						Rs	61.02	589.49

8	5.9.2	Centering and shuttering including strutting, propping etc. and removal of form for :Walls (any thickness) including attached pilasters, butteresses, plinth and string courses etc.								
		For walls outside	2	12.00		4.10	98.40	m^2		
		For walls inside	2	10.80		4.10	88.6	m^2		
		Top slab	1	5.40	5.4		29.2	m^2		
		Top beams	2	5.40		0.90	9.7	m^2		
		Total					225.84	m^2		
		Say		225.84	m^2		@	Rs	716.35	161781.51
		GST component						Rs	130.53	29479.27
9	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm								
		Inside of walls	2	10.80		4.10	88.56	m^2		
		Top slab	1	5.40	5.4		29.16	m^2		
		Top beams	2	5.40		0.90	9.7	m^2		
		Total					127.44	m^2		
		Say		127.44	m^2		@	Rs	569.6	72585.78
		GST component						Rs	103.8	13226.33
10	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.								

		Bottom slab inside	1	5.40	5.4		29.16	m^2		
		Total					29.16	m^2		
		Say		29.16	m^2		@	Rs	439.01	12801.44
		GST component						Rs	79.99	2332.63
11	13.7.1	12 mm cement plaster finished with a floating coat of neat cement :1:3 (1 cement : 3 fine sand)								
		Inside of walls	2	10.80		4.10	88.56	m^2		
		Base slab inside	1	5.40	5.4		29.16	m^2		
		Total					117.7	m^2		
		Say		117.7	m^2		@	Rs	400.74	47174.84
		GST component						Rs	73.02	8596.04
		Total-MBBR Tank-2								₹ 13,78,794
		GST component								₹ 2,51,239

5.11MBBR TANK FOR BOD REMOVAL AFTER DE-NITRIFICATION

MOVING BED BIOFILM REACTOR TANK- CHAMBER AFTER DE-NITRIFICATION										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
		Shape of tank	1	(put 1 for rectangular and 2 for circular)						
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead up to 50 m and lift up to 1.5 m, as directed by Engineer-in-charge								
		MBBR Tank-base	1	4.85	4.85	0.45	10.59	m^3		
		Total					10.59	m^3		
		Say		10.59	m^3		@	Rs	213.86	2264.78
		GST component						Rs	38.97	412.68
2	7.1.1	Random rubble masonry in hard stone in foundation and plinth including levelling up with cement concrete 1:6:12 up to plinth level with cement mortar 1:6								
		MBBR Tank-base	1	4.85	4.85	0.45	10.59	m^3		
		Total					10.59	m^3		
		Say		10.59	m^3		@	Rs	7196.2	76208.08
		GST component						Rs	1311.3	13886.38
3	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		MBBR tank-base	1	4.85	4.85	0.15	3.53	m^3		
		Total					3.53	m^3		

		Say		3.53	m^3		@	Rs	7202.34	25424.27
		GST component						Rs	1312.39	4632.72
4	5.37.1 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/^{3}.Excess/less cement used as per design mix is payable/recoverable separately).								
		Base slab	1	4.85	4.85	0.35	8.23	m^3		
		Tank walls	2	7.30	0.30	4.10	17.96	m^3		
		Total					26.19	m^3		
		Say		26.19	m^3		@	Rs	9956.31	260764.35
		GST component						Rs	1814.20	47515.59
5	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.2	1		26.19	m^3	120	kg/m^3	3142.905	kg
		Total							3142.905	kg
		Say		2738	kg		@	Rs	98.17	268792.26
		GST component						Rs	17.89	48978.41
6	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								
		Quantity as per item No.2	1		26.19	m^3	340	kg/m^3	8904.8975	kg
		Total							8904.8975	kg
		Say		178.10	bags		@	Rs	66.49	11841
		GST component						Rs	12.11	2157.63
7	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								
		Bottom slab	2	9.70		0.45	8.73	m^2		
		Total					8.73	m^2		
		Say		8.73	m^2		@	Rs	334.9	2923.66
		GST component						Rs	61.0	532.74
8	5.9.2	Centering and shuttering including strutting, propping etc. and removal of form for :Walls (any thickness) including attached pilasters, butteresses, plinth and string courses etc.								

		For walls outside	2	7.90		4.10	64.78	m^2		
		For walls inside	2	6.70		4.10	54.9	m^2		
		Total					119.72	m^2		
		Say		119.72	m^2		@	Rs	716.35	85761.97
		GST component						Rs	130.53	15627.25
9	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm									
		Inside of walls	2	6.70		4.10	54.94	m^2		
		Total					54.94	m^2		
		Say		54.94	m^2		@	Rs	569.57	31292.08
		GST component						Rs	103.78	5701.94
10	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoirs, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.									
		Bottom slab inside	1	3.35	3.35		11.22	m^2		
		Total					11.22	m^2		
		Say		11.22	m^2		@	Rs	439.00671	4926.75
		GST component						Rs	79.994303	897.74
11	13.7.1	12 mm cement plaster finished with a floating coat of neat cement:1:3 (1 cement : 3 fine sand)								
		Inside of walls	2	6.70		4.10	54.94	m^2		

		Base slab inside	1	3.35	3.35		11.22	m^2		
		Total					66.16	m^2		
		Say		66.16	m^2		@	Rs	400.74	26513.8
		GST component						Rs	73.02	4831.25
		Total-MBBR Tank-2								₹ 7,96,713
		GST component								₹ 1,45,174

5.12 SECONDARY CLARIFIER WITH PLATE SETTLER

SECONDARY CLARIFIER WITH PLATE SETTLER										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead up to 50 m and lift up to 1.5 m, as directed by Engineer-in-charge								
		For clarifier	1	6	6	0.75	27	m^3		
		Total					27	m^3		
		Say		27	m^3		@	Rs	213.86	5774.22
		GST component						Rs	38.97	1052.16
2	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		For clarifier foundation	1	6	6	0.15	5.4	m^3		
		Total					5.4	m^3		
		Say		5.4	m^3		@	Rs	7202.34	38892.66
		GST component						Rs	1312.39	7086.89
3	5.37.1 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/^{3}.Excess/less cement used as per design mix is payable/recoverable separately). Up to plinth level.								
		Base slab-raft beam slab type	1	6	6	0.35	12.60	m^3		
		Base slab-inverted beams	4	4.38	0.42	0.6	4.46	m^3		
		Total					17.06	m^3		

		Say		17.06	m^3		@	Rs	9956.31	169879.46
		GST component						Rs	1814.20	30954.86
4	5.37.2 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/m^3.Excess/less cement used as per design mix is payable/recoverable separately). Above plinth level.									
		Columns-long	4	0.35	0.35	3.1	1.52	m^3		
		Columns-short	4	0.35	0.35	0.7	0.34	m^3		
		Clarifier-square container	4	4.50	0.3	2.9	15.66	m^3		
		Clarifier-hopper container	4	3.15	0.3	2.75	10.41	m^3		
		Top beams	4	4.65	0.2	1.05	3.91	m^3		
		Total					31.28	m^3		
		Deductions								
		Inlet pipe	1	0.031	0.3		0.01	m^3		
		Total					31.83	m^3		
		Say		31.83	m^3		@	Rs	11606.5	369402.43
		GST component						Rs	2114.9	67311.25
5	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete up to plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.3	1		17.06	m^3	120	kg/m^3	2047.5	kg
		Quantity as per item No.4	1		31.83	m^3	120	kg/m^3	3819.2774	kg
		Total							5866.7774	kg
		Say		5867	kg		@	Rs	98.2	575947.55
		GST component						Rs	17.9	104947.19
6	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								
		Quantity as per item No.3	1		17.06	m3	340	kg/m^3	5801.3	kg

		Quantity as per item No.4	1		31.83	m3	340	kg/m^3	10821.286	kg
		Total							16622.5	kg
		Say		332.5	bags		@	Rs	66.5	22103.28
		GST component						Rs	12.1	4027.58
7	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								
		Base slab-raft beam slab type	4	6.00		0.35	8.40	m^2		
		Base slab-inverted beams	4	4.80		0.6	11.52	m^2		
		Base slab-inverted beams	4	3.95		0.6	9.48	m^2		
		Top channels	4	5.25		1.20	25.20	m^2		
		Total					54.60	m^2		
		Say		54.60	m^2		@	Rs	334.9	18285.45
		GST component						Rs	61.0	3331.91
8	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm								
		Inside of walls-upper	4	4.20		2.9	48.72	m^2		
		Inside of walls-lower	4	2.85		2.75	31.39	m^2		
		Top channels	4	5.25	1.05		22.05	m^2		
		Total					102.16	m^2		
		Say		102.16	m^2		@	Rs	569.57	58187.91
		GST component						Rs	103.78	10602.8

9	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.								
		Bottom slab inside	1	1.50	1.5		2.25	m^2		
		Total					2.25	m^2		
		Say		2.25	m^2		@	Rs	439.01	987.77
		GST component						Rs	79.99	179.99
10	13.7.1	12 mm cement plaster finished with a floating coat of neat cement :1:3 (1 cement : 3 fine sand)								
		Inside of walls-upper	4	4.20		2.9	48.72	m^2		
		Inside of walls-lower	4	2.85		2.75	31.39	m^2		
		Top channels	4	5.25		1.05	22.05	m^2		
		Base slab inside	4	1.50	1.5		9.00	m^2		
		Total					111.16	m^2		
		Say		111.16	m^2		@	Rs	400.74	44546.57
		GST component						Rs	73.02	8117.12
		Total-Secondary Clarifier with Plate Settler								₹ 13,04,007
		GST component								₹ 2,37,612

5.13 SLUDGE SUMP

SLUDGE SUMP-*circular*										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead up to 50 m and lift up to 1.5 m, as directed by Engineer-in-charge								
		For sludge sump	1	2.95	2.95	3.25	28.28	m^3		
		Total					28.28	m^3		
		Say		28.28	m^3		@	Rs	213.86	6047.96

		GST component						Rs	38.97	1102.04
2	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		For sludge sump	1	2.95	2.95	0.15	1.31	m^3		
		Total					1.31	m^3		
		Say		1.31	m^3		@	Rs	7202.3	9435.07
		GST component						Rs	1312.4	1719.23
3	5.37.1 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/^{3}.Excess/less cement used as per design mix is payable/recoverable separately).								
		Base slab	1	2.95	2.95	0.3	2.61	m^3		
		Tank walls	1	6.44	0.3	3.1	5.99	m^3		
		Total					8.60	m^3		
		Say		8.60	m^3		@	Rs	9956.31	85595.95
		GST component						Rs	1814.20	15597
4	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.3	1		8.60	m^3	120	kg/m^3	1031.6592	kg
		Total							1031.6592	kg
		Say		1032	kg		@	Rs	98.17	101279.04
		GST component						Rs	17.89	18454.72
5	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								
		Quantity as per item No.3	1		8.60	m^3	340	kg/m^3	2923.0344	kg
		Total							2923.0344	kg
		Say		58.46	bags		@	Rs	66.5	3886.81
		GST component						Rs	12.1	708.24
6	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								
		Bottom slab	4	2.95		0.3	3.54	m^2		
		Total					3.54	m^2		
		Say		3.54	m^2		@	Rs	334.9	1185.54

		GST component						Rs	61.0	216.03
7	5.9.2	Centering and shuttering including strutting, propping etc. and removal of form for :Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.								
		For walls outside	1	7.38		3.1	22.87	m^2		
		For walls inside	1	5.50		3.1	17.0	m^2		
		Total					39.91	m^2		
		Say		39.91	m^2		@	Rs	716.4	28589.28
		GST component						Rs	130.5	5209.44
8	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm								
		Inside of walls	1	5.50		3.1	17.03	m^2		
		Total					17.03	m^2		
		Say		17.03	m^2		@	Rs	569.57	9702.31
		GST component						Rs	103.78	1767.92
9	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.								
		Bottom slab inside	1	2.41			2.41	m^2		
		Total					2.41	m^2		
		Say		2.41	m^2		@	Rs	439.0	1055.94
		GST component						Rs	80.0	192.41

10	13.7.1	12 mm cement plaster finished with a floating coat of neat cement :1:3 (1 cement : 3 fine sand)								
		Inside of walls	1	5.50		3.1	17.03	m^2		
		Base slab inside	1	2.41			2.41	m^2		
		Total					19.44	m^2		
		Say		19.44	m^2		@	Rs	400.74	7790.25
		GST component						Rs	73.02	1419.51
		Total-Sludge Sump								₹ 2,54,568
		GST component								₹ 46,387

5.14 SLUDGE THICKENER

SLUDGE THICKENER-*circular*										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge								
		For sludge thickener	1	4.6	4.6	3	63.48	m^3		
		Total					63.48	m^3		
		Say		63.48	m^3		@	Rs	213.86	13575.83
		GST component						Rs	38.97	2473.74
2	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		For sludge thickener	1	4.6	4.6	0.15	3.17	m^3		
		Total					3.17	m^3		
		Say		3.17	m^3		@	Rs	7202.3	22831.43
		GST component						Rs	1312.4	4160.27
3	5.37.1 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/^{3}.Excess/less cement used as per design mix is payable/recoverable separately).								

		Base slab	1	4.6	4.6	0.35	7.41	m^3		
		Tank walls	1	11.30	0.3	2.5	8.48	m^3		
		Total					15.88	m^3		
		Say		15.88	m^3		@	Rs	9956.31	158145.96
		GST component						Rs	1814.20	28816.82
4	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.3	1		15.88	m^3	120	kg/m^3	1906.08	kg
		Total							1906.08	kg
		Say		1906	kg		@	Rs	98.17	187121.83
		GST component						Rs	17.89	34096.7
5	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								
		Quantity as per item No.3	1		15.88	m^3	340	kg/m^3	5400.56	kg
		Total							5400.56	kg
		Say		108.01	bags		@	Rs	66.49	7181.22
		GST component						Rs	12.11	1308.54
6	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								
		Bottom slab	4	4.60		0.35	6.44	m^2		
		Total					6.44	m^2		
		Say		6.44	m^2		@	Rs	334.9	2156.75
		GST component						Rs	61.0	392.99
7	5.9.2	Centering and shuttering including strutting, propping etc. and removal of form for :Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.								
		For walls outside	1	12.25		2.5	30.62	m^2		
		For walls inside	1	10.36		2.5	25.9	m^2		
		Total					56.52	m^2		
		Say		56.52	m^2		@	Rs	716.35	40488.36
		GST component						Rs	130.53	7377.65

8	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm								
		Inside of walls	1	10.36		2.5	25.91	m^2		
		Total					25.91	m^2		
		Say		25.91	m^2		@	Rs	569.6	14754.67
		GST component						Rs	103.8	2688.54
9	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.								
		Bottom slab inside	1	8.55			8.55	m^2		
		Total					8.55	m^2		
		Say		8.55	m^2		@	Rs	439.01	3754.83
		GST component						Rs	79.99	684.19
10	13.7.1	12 mm cement plaster finished with a floating coat of neat cement :1:3 (1 cement : 3 fine sand)								
		Inside of walls	1	3.77		1.75	6.59	m^2		
		Base slab inside	1	1.13			1.13	m^2		
		Total					7.72	m^2		
		Say		7.75	m^2		@	Rs	400.74	3105.72
		GST component						Rs	73.02	565.91
		Total- Sludge Thickener								₹ 4,53,117
		GST component								₹ 82,565

5.15 CHLORINE CONTACT TANK

CHLORINE CONTACT TANK-*rectangular*										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge								
		For chlorine contact tank	1	4.95	4.95	2.55	62.48	m^3		
		Total					62.48	m^3		
		Say		62.48	m^3		@	Rs	213.86	13361.97
		GST component						Rs	38.97	2434.77
2	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		For chlorine contact tank	1	4.95	4.95	0.15	3.68	m^3		
		Total					3.68	m^3		
		Say		3.68	m^3		@	Rs	7202.3	26504.62
		GST component						Rs	1312.4	4829.58
3	5.37.1 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/^{3}.Excess/less cement used as per design mix is payable/recoverable separately).								
		Base slab	1	4.95	4.95	0.35	8.58	m^3		
		Tank walls	4	4.05	0.3	2.35	11.42	m^3		
		Total					20.00	m^3		
		Say		20.00	m^3		@	Rs	9956.31	199094.99
		GST component						Rs	1814.20	36278.41
4	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.3	1		20.00	m^3	120	kg/m^3	2399.625	kg
		Total							2399.625	kg

		Say		2400	kg		@	Rs	98.17	235573.64
		GST component						Rs	17.89	42925.42
5	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								
		Quantity as per item No.3	1		20.00	m^3	340	kg/m^3	6798.9375	kg
		Total							6798.9375	kg
		Say		135.98	bags		@	Rs	66.49	9040.67
		GST component						Rs	12.11	1647.36
6	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								
		Bottom slab	4	4.95		0.35	6.93	m^2		
		Total					6.93	m^2		
		Say		6.93	m^2		@	Rs	334.9	2320.85
		GST component						Rs	61.0	422.9
7	5.9.2	Centering and shuttering including strutting, propping etc. and removal of form for :Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.								
		For walls outside	4	4.35		2.35	40.89	m^2		
		For walls inside	4	3.75		2.35	35.3	m^2		
		Total					76.14	m^2		
		Say		76.14	m^2		@	Rs	716.35	54543.24
		GST component						Rs	130.53	9938.68
8	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm								
		Inside of walls	4	3.75		2.35	35.25	m^2		
		Total					35.25	m^2		
		Say		35.25	m^2		@	Rs	569.6	20077.28
		GST component						Rs	103.8	3658.41

9	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.								
		Bottom slab inside	1	3.75	3.75		14.06	m^2		
		Total					14.06	m^2		
		Say		14.06	m^2		@	Rs	439.01	6173.53
		GST component						Rs	79.99	1124.92
10	13.7.1	12 mm cement plaster finished with a floating coat of neat cement :1:3 (1 cement : 3 fine sand)								
		Inside of walls	4	3.75		2.35	35.25	m^2		
		Base slab inside	1	3.75	3.75		14.06	m^2		
		Total					49.31	m^2		
		Say		49.31	m^2		@	Rs	400.74	19761.38
		GST component						Rs	73.02	3600.85
		Total-Chlorine Contact Tank								₹ 5,86,452
		GST component								₹ 1,06,861

5.16 FILTER FEED TANK

FILTER FEED TANK-*rectangular*										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge								
		For filter feed tank	1	4.2	4.2	2.5	44.1	m^3		
		Total					44.1	m^3		
		Say		44.1	m^3		@	Rs	213.9	9431.23
		GST component						Rs	39.0	1718.53

2	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		For filter feed tank	1	4.2	4.2	0.15	2.65	m^3		
		Total					2.65	m^3		
		Say		2.65	m^3		@	Rs	7202.3	19086.21
		GST component						Rs	1312.4	3477.82
3	5.37.1 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/^{3}.Excess/less cement used as per design mix is payable/recoverable separately).								
		Base slab	1	4.2	4.2	0.3	5.29	m^3		
		Tank walls	2	6.70	0.25	2.35	7.87	m^3		
		Total					13.16	m^3		
		Say		13.16	m^3		@	Rs	9956.31	131069.78
		GST component						Rs	1814.20	23883.09
4	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.3	1		13.16	m^3	120	kg/m^3	1579.74	kg
		Total							1579.74	kg
		Say		1580	kg		@	Rs	98.17	155084.69
		GST component						Rs	17.89	28259
5	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								
		Quantity as per item No.3	1		13.16	m^3	340	kg/m^3	4475.93	kg
		Total							4475.93	kg
		Say		89.52	bags		@	Rs	66.49	5951.72
		GST component						Rs	12.11	1084.5
6	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								
		Bottom slab	2	8.40		0.3	5.04	m^2		
		Total					5.04	m^2		

		Say		5.04	m^2		@	Rs	334.9	1687.89
		GST component						Rs	61.0	307.56
7	5.9.2	Centering and shuttering including strutting, propping etc. and removal of form for :Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.								
		For walls outside	2	7.20		2.35	33.84	m^2		
		For walls inside	2	6.20		2.35	29.1	m^2		
		Total					62.98	m^2		
		Say		62.98	m^2		@	Rs	716.35	45116.01
		GST component						Rs	130.53	8220.89
8	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm								
		Inside of walls	2	6.20		2.35	29.14	m^2		
		Total					29.14	m^2		
		Say		29.14	m^2		@	Rs	569.6	16597.22
		GST component						Rs	103.8	3024.29
9	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.								
		Bottom slab inside	1	3.10	3.10		9.61	m^2		
		Total					9.61	m^2		
		Say		9.61	m^2		@	Rs	439.01	4218.85
		GST component						Rs	79.99	768.75

10	13.7.1	12 mm cement plaster finished with a floating coat of neat cement :1:3 (1 cement : 3 fine sand)								
		Inside of walls	2	6.20		2.35	29.14	m^2		
		Base slab inside	1	3.10	3.1		9.61	m^2		
		Total					38.75	m^2		
		Say		38.75	m^2		@	Rs	400.74	15528.58
		GST component						Rs	73.02	2829.57
		Total- Filter Feed Tank								₹ 4,03,772
		GST component								₹ 73,574

5.17 TREATED WATER TANK

TREATED WATER TANK-*rectangular*										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge								
		For treated water tank	1	5.85	5.85	3	102.7	m^3		
		Total					102.7	m^3		
		Say		102.7	m^3		@	Rs	213.86	21957.01
		GST component						Rs	38.97	4000.93
2	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		For treated water tank	1	5.85	5.85	0.15	5.13	m^3		
		Total					5.13	m^3		
		Say		5.13	m^3		@	Rs	7202.3	36948.02
		GST component						Rs	1312.4	6732.54
3	5.37.1 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/^{3}.Excess/less cement used as per design mix is payable/recoverable separately).								
		Base slab	1	5.85	5.85	0.3	10.27	m^3		
		Tank walls	2	10.00	0.25	2.85	14.25	m^3		

		Total					24.52	m^3		
		Say		24.52	m^3		@	Rs	9956.31	244096.25
		GST component						Rs	1814.20	44478.38
4	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.3	1		24.52	m^3	120	kg/m^3	2942.01	kg
		Total							2942.01	kg
		Say		2942	kg		@	Rs	98.17	288820.14
		GST component						Rs	17.89	52627.82
5	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								
		Quantity as per item No.3	1		24.52	m^3	340	kg/m^3	8335.695	kg
		Total							8335.695	kg
		Say		166.71	bags		@	Rs	66.49	11084.12
		GST component						Rs	12.11	2019.71
6	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								
		Bottom slab	2	11.70		0.3	7.02	m^2		
		Total					7.02	m^2		
		Say		7.02	m^2		@	Rs	334.9	2350.99
		GST component						Rs	61.0	428.39
7	5.9.2	Centering and shuttering including strutting, propping etc. and removal of form for :Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.								
		For walls outside	2	10.50		2.85	59.85	m^2		
		For walls inside	2	9.50		2.85	54.2	m^2		
		Total					114.00	m^2		
		Say		114.00	m^2		@	Rs	716.4	81664.42
		GST component						Rs	130.5	14880.61

8	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservior, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm								
		Inside of walls	2	9.50		2.85	54.15	m^2		
		Total					54.15	m^2		
		Say		54.15	m^2		@	Rs	569.6	30842.12
		GST component						Rs	103.8	5619.95
9	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.								
		Bottom slab inside	1	4.75	4.75		22.56	m^2		
		Total					22.56	m^2		
		Say		22.56	m^2		@	Rs	439.01	9905.09
		GST component						Rs	79.99	1804.87
10	13.7.1	12 mm cement plaster finished with a floating coat of neat cement :1:3 (1 cement : 3 fine sand)								
		Inside of walls	2	9.50		2.85	54.15	m^2		
		Base slab inside	1	4.75	4.75		22.56	m^2		
		Total					76.71	m^2		
		Say		76.71	m^2		@	Rs	400.74	30741.59
		GST component						Rs	73.02	5601.63
		Total- Treated water Tank								₹ 7,58,410
		GST component								₹ 1,38,195

5.18 SEWER NETWORK WITH MANHOLES, LIFTING STATIONS AND WELLS

SEWER NETWORK WITH PIPES, MANHOLES, INSPECTION CHAMBERS AND WELLS										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
1	2.6.1	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge								
		For manholes-class 1 (0.9 m dia)	459	1.90	1.90	1.56	2585	m^3		
		For manholes-class 2 (1.2 m dia)	43	2.30	2.30	2.50	568.7	m^3		
		For manholes-class 3 (1.5 m dia)	61	2.70	2.70	3.53	1570	m^3		
		Extra depth for lift manholes	6	2.70	2.70	0.50	21.87	m^3		
		For collection well-1	1	6.90	6.90	6.70	319	m^3		
		For collection well-2	1	6.90	6.90	6.70	319	m^3		
		For lift manhole panel board foundation	6	1.00	0.45	0.60	1.62	m^3		
		For sewer chambers	1126	1.30	1.30	1.00	1903	m^3		
		Total					7288	m^3		
		Say		7288	m^3		@	Rs	213.9	1558558
		GST component						Rs	38.97	283995
2	4.1.6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level : 1:3:6 (1 Cement : 3 coarse sand (zone-III): 6 graded stone aggregate 40 mm nominal size)								
		For manholes-class 1 (0.9 m dia)	459	1.90	1.90	0.15	248.6	m^3		
		For manholes-class 2 (1.2 m dia)	43	2.30	2.30	0.15	34.12	m^3		
		For manholes-	61	2.70	2.70	0.15	66.7	m^3		

		class 3 (1.5 m dia)								
		For collection well-1	1	6.90	6.90	0.15	7.14	m^3		
		For collection well-2	1	6.90	6.90	0.15	7.14	m^3		
		For lift manhole panel board foundation	6	1.00	0.45	0.60	1.62	m^3		
		For sewer chambers	1126	1.30	1.30	0.15	285.4	m^3		
		For pipeline support base/6 m	3404	0.30	0.30	0.1	30.64	m^3		
		Total					681.4	m^3		
		Say		681.4	m^3		@	Rs	7202.3	4907316.85
		GST component						Rs	1312.4	894194.51
3	5.37.1 + 5.34.1	Providing and laying in position ready mixed M-30 grade concrete for reinforced cement concrete work, using Sulphate Resistant Cement (SRC) content as per approved design mix, manufactured in fully automatic batching plant and transported to site of work in transit mixer for all leads, having continuous agitated mixer, manufactured as per mix design of specified grade for reinforced cement concrete work, including pumping of R.M.C. from transit mixer to site of laying , excluding the cost of centering, shuttering finishing and reinforcement, including cost of admixtures in recommended proportions as per IS : 9103 to accelerate/ retard setting of concrete, improve workability without impairing strength and durability as per direction of the Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/m^3.Excess/less cement used as per design mix is payable/recoverable separately).								
		Base slab - manhole class-1	459	1.90	1.90	0.35	579.95	m^3		
		Base slab - manhole class-2	43	2.30	2.30	0.40	90.99	m^3		
		Base slab - manhole class-3	61	2.70	2.70	0.45	200.11	m^3		
		Base slab collection well-1	1	6.90	6.90	0.45	21.42	m^3		
		Base slab collection well-2	1	6.90	6.90	0.45	21.42	m^3		
		Walls-manhole class-1	459	0.90		1.06	438.86	m^3		
		Walls-manhole class-2	43	1.41		1.95	118.51	m^3		
		Walls-manhole class-3	61	2.03		2.93	364.02	m^3		

		Extra depth for lift manholes	6	2.03		0.50	6.10	m^3		
		Walls-collection well-1	1	7.85		6.10	47.86	m^3		
		Walls-collection well-2	1	7.85		6.10	47.86	m^3		
		Top slab-manhole class-1	459	1.54		0.2	141.32	m^3		
		Top slab-manhole class-2	43	2.54		0.2	21.88	m^3		
		Top slab-manhole class-3	61	3.80		0.2	46.38	m^3		
		Chamber slab	1126	1.00	1.00	0.2	225.20	m^3		
		Chamber walls	1126	2.40	0.20	0.5	270.24	m^3		
		Chamber cover slab	1126	1.00	1.00	0.1	112.60	m^3		
		Deduct manhole cover (600 mm dia)	563	0.28		0.15	-23.88	m^3		
		Total					2730.8	m^3		
		Say		2730.8	m^3		@	Rs	9956.3	27189160.55
		GST component						Rs	1814.2	4954315.96
4	5.22.6	Epoxy coated steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level. Thermo-Mechanically Treated bars of grade Fe-500D or more.								
		Quantity as per item No.3	1		2730.8	m^3	110	kg/m^3	300393.32	kg
		Total							300393.32	kg
		Say		3E+05	kg		@	Rs	98.17	29489920.14
		GST component						Rs	17.89	5373552.51
5	4.12	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.								
		Quantity as per item No.3	1		2730.8	m^3	340	kg/m^3	928488.45	kg
		Total							928488.45	kg
		Say		18570	bags		@	Rs	66.49	1234627.53

		GST component						Rs	12.11	224969.61
6	5.9.1	Centering and shuttering including strutting, propping etc. and removal of form for :Foundations, footings, bases of columns, etc. for mass concrete								
		Base slab								
		For manholes-class 1	459	7.6		0.35	1221	m^2		
		For manholes-class 2	43	9.2		0.40	158.2	m^2		
		For manholes-class 3	61	10.8		0.45	296.5	m^2		
		For collection well-1	1	27.6		0.45	12.42	m^2		
		For collection well-2	1	27.6		0.45	12.42	m^2		
		For sewer chambers	1126	4.00		0.20	900.8	m^2		
		Total					2601.3	m^2		
		Say		2601.3	m^2		@	Rs	334.9	871164.51
		GST component						Rs	61.0	158740.62
7	5.9.2	Centering and shuttering including strutting, propping etc. and removal of form for :Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.								
		For walls outside								
		For manholes-class 1	459	4.40		1.06	2136.0	m^2		
		For manholes-class 2	43	5.65		1.95	473.81	m^2		
		For manholes-class 3	61	6.91		2.93	1236.2	m^2		
		Extra depth for lift manholes	6	6.91		0.50	20.7	m^2		
		For collection well-1	1	18.84		6.10	114.92	m^2		
		For collection well-2	1	18.84		6.10	114.92	m^2		
		For sewer chambers	1126	4.00		0.50	2252.0	m^2		
		For walls inside								
		For manholes-class 1	459	2.83		1.06	1373.1	m^2		

		For manholes-class 2	43	3.77		1.95	315.9	m^2		
		For manholes-class 3	61	4.71		2.93	842.9	m^2		
		For collection well-1	1	16.01		6.10	97.7	m^2		
		For collection well-2	1	16.01		6.10	97.7	m^2		
		For sewer chambers	1126	2.40		0.50	1351.2	m^2		
		Total					10427	m^2		
		Say		10427	m^2		@	Rs	716.35	7469400
		GST component						Rs	130.53	1361049
8	22.23.1	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For vertical surface two coats @ 0.70 kg per sqm								
		Inside of walls								
		For manholes-class 1	459	2.83		1.06	1373.1	m^2		
		For manholes-class 2	43	3.77		1.95	315.9	m^2		
		For manholes-class 3	61	4.71		2.93	842.9	m^2		
		Extra depth for lift manholes	6	4.71		0.50	14.1	m^2		
		For collection well-1	1	16.01		6.10	97.7	m^2		
		For collection well-2	1	16.01		6.10	97.7	m^2		
		For sewer chambers	1126	2.40		0.50	1351.2	m^2		
		Total					4092.6	m^2		
		Say		4092.6	m^2		@	Rs	569.6	2330987.8

		GST component						Rs	103.8	424744.63
9	22.23.2	Providing and applying integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fibre brush. The material shall meet the requirements as specified in ACI212-3R-2010 i.e. by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the engineer-in-charge. The product performance shall carry guarantee for 10 years against any leakage. For horizontal surface one coat @1.10 kg per sqm.								
		Bottom slab								
		For manholes-class 1	459	0.64			292.0	m^2		
		For manholes-class 2	43	1.13			48.6	m^2		
		For manholes-class 3	61	1.77			107.8	m^2		
		For collection well-1	1	20.43			20.4	m^2		
		For collection well-2	1	20.43			20.4	m^2		
		For sewer chambers	1126	0.36			405.4	m^2		
		Total					894.65	m^2		
		Say		894.65	m^2		@	Rs	439.01	392756.69
		GST component						Rs	79.99	71566.78
10	2.25	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m.								
		Quantity as per item 1	1				7286.9	m^3		
		Deductions								
		PCC	1				681.4	m^3		
		Bottom slab-manholes+ chambers	1				1096.2	m^3		
		Bottom slab-collection wells	1				42.8	m^3		

		Walls-manholes+ chambers	1				1191.6	m^3		
		Walls-collection wells	1				95.7			
		Top slab-manholes+ chambers	1				322.2	m^3		
		Quantity after deductions	1				3995.5	m^3		
		Say		3995.5	m^3		@	Rs	258.2	1031808.3
		GST component						Rs	47.1	188012.58
11	100.98.139	Supply of PE Pipe, PE100, PN8, 180 mm dia, conforming to IS 4984/2016								
		For connection from chamber to manholes	1126	6			6756	m		
		Total					6756	m		
		Say		6756	m		@	Rs	856.1	₹ 57,83,474
		GST component						Rs	154.1	₹ 10,41,025
12	100.98.141	Supply of PE Pipe, PE100, PN8, 225 mm dia, conforming to IS 4984/2016								
		For sewer network								
			1	12668			12668	m		
		Total					12668	m		
		Say		12668	m		@	Rs	1337	₹ 1,69,36,352
		GST component						Rs	241	₹ 30,48,543
13	100.98.143	Supply of PE Pipe, PE100, PN8, 280 mm dia, conforming to IS 4984/2016.								
		For sewer network								
			1	578.3			578	m		
		Total					578.3	m		
		Say		578.3	m		@	Rs	2066.3	₹ 11,94,900
		GST component						Rs	371.93	₹ 2,15,082

14	100.98.145	Supply of PE Pipe, PE100, PN8, 355 mm dia, conforming to IS 4984/2016.								
		For sewer network								
			1	421			421	m		
		Total					421	m		
		Say		421	m		@	Rs	3313.8	₹ 13,95,089
		GST component						Rs	596.5	₹ 2,51,116
15	100.98.161	Supply of PE Pipe, PE100, PN10, 225 mm dia, conforming to IS 4984/2016.								
		For sewer network pumping line-lifting stations	2	180			360	m		
		For well-2 to well-1	2	50			100	m		
		Total					460	m		
		Say		460	m		@	Rs	1643.5	₹ 7,56,010
		GST component						Rs	295.83	₹ 1,36,082
16	100.98.163	Supply of PE Pipe, PE100, PN10, 280 mm dia, conforming to IS 4984/2016.								
		For well-1 to STP	2	900			1800	m		
		Total					1800	m		
		Say		1800	m		@	Rs	2538	₹ 45,68,220
		GST component						Rs	457	₹ 8,22,280
17	2.10.1	Excavating trenches of required width for pipes, cables, etc including excavation for sockets, and dressing of sides, ramming of bottoms, depth upto 1.5 m, including getting out the excavated soil, and then returning the soil as required, in layers not exceeding 20 cm in depth, including consolidating each deposited layer by ramming, watering, etc. and disposing of surplus excavated soil as directed, within a lead of 50 m :								
	2.10.1.2	Pipes, cables etc. exceeding 80 mm dia. but not exceeding 300 mm dia								
		For depth 0 - 1.50 m								
			1				19104	m^3		
		For lifting stations	1	120.00	1.20	1.40	201.6	m^3		
		From well-2 to well-1	1	35.00	1.20	1.40	58.8	m^3		
		Total					19365	m^3		
		Say		19365	m^3		@	Rs	428.19	8291835

		GST component						Rs	78.02	1510910
18	2.11	For depth 1.50 - 3.00 m								
			1				3082	m^3		
		For lifting stations	1	60.00	1.20	2.50	180	m^3		
		From well-2 to well-1	1	15.00	1.20	2.20	39.6	m^3		
		Total					3302	m^3		
		Say		3301.8	m^3		@	Rs	543.80	1795532
		GST component						Rs	99.09	327176
19	2.12	For depth 3.00 - 4.50 m								
			1				198.4	m^3		
		Pumping lines-Lift Stations								
		Pumping lines-well to well & STP								
		Total					198.4	m^3		
		Say		198.45	m^3		@	Rs	1349.01	267708
		GST component						Rs	245.81	48781
20	100.10.6	Laying HDPE pipes (IS : 4984)on land portion including conveying within initial lead and aligning the pipes, electro-fusion welding using automatic or semi automatic electrofusion machines, testing the pipe line thus fabricated to suit the hydraulic working pressure and after testing , aligning the pipeline, lowering the pipe in position into the trenches already made, testing the line to suitable pressure with potable water before back filling and leveling the trenches including all labour charge, hire for appliances etc. complete but excluding cost of pipe and fittings.								
		For sewer network - 180 mm OD HDPE pipes								
			1	6756			6756	m		
		Total					6756	m		
		Say		6756	m		@	Rs	265.55	₹ 17,94,076
		GST component						Rs	47.80	₹ 3,22,934

21	100.10.8	Laying HDPE pipes (IS : 4984)on land portion including conveying within initial lead and aligning the pipes, electro-fusion welding using automatic or semi automatic electrofusion machines, testing the pipe line thus fabricated to suit the hydraulic working pressure and after testing , aligning the pipeline, lowering the pipe in position into the trenches already made, testing the line to suitable pressure with potable water before back filling and leveling the trenches including all labour charge, hire for appliances etc. complete but excluding cost of pipe and fittings.								
		For sewer network - 225 mm OD HDPE pipes								
		Sewer network	1	12668			12668	m		
		Lifting lines	1	360			360	m		
		Well-2 to well-1	1	100			100	m		
		Total					13128	m		
		Say		13128	m		@	Rs	377.28	₹ 49,53,063
		GST component						Rs	67.91	₹ 8,91,551
22	100.10.10	Laying HDPE pipes (IS : 4984)on land portion including conveying within initial lead and aligning the pipes, electro-fusion welding using automatic or semi automatic electrofusion machines, testing the pipe line thus fabricated to suit the hydraulic working pressure and after testing , aligning the pipeline, lowering the pipe in position into the trenches already made, testing the line to suitable pressure with potable water before back filling and leveling the trenches including all labour charge, hire for appliances etc. complete but excluding cost of pipe and fittings.								
		For sewer network - 280 mm OD HDPE pipes								
		Sewer network	1	578.3			578.3	m		
		Well-1 to STP	1	1800			1800	m		
		Total					2378	m		
		Say		2378	m		@	Rs	519.78	₹ 12,36,193
		GST component						Rs	93.56	₹ 2,22,515
23	100.10.12	Laying HDPE pipes (IS : 4984)on land portion including conveying within initial lead and aligning the pipes, electro-fusion welding using automatic or semi automatic electrofusion machines, testing the pipe line thus fabricated to suit the hydrulic working pressure and after testing , aligning the pipeline, lowering the pipe in position into the trenches already made, testing the line to suitable pressure with potable water before back filling and leveling the trenches including all labour charge, hire for appliances etc. complete but excluding cost of pipe and fittings.								
		For sewer network - 355 mm OD HDPE pipes								
			1	421			421	m		
		Total					421	m		

		Say		421	m		@	Rs	655.58	₹ 2,75,998
		GST component						Rs	118	₹ 49,680
24		Supply and fixing 250 mm butterfly valves								
		For pumping lines								
			8				8	m		
		Total					8	m		
		Say		8	m		@	Rs	25000	₹ 2,00,000
		GST component						Rs	4500	₹ 36,000
25		Road restoration charges for excavated portions of Bitumen Macadam and Bitumen Concrete (BMBC), interlocked tiled surface and municipal roads								
		For sewer network including manholes								
		BM/BC roads	1	4160	1.2		4992	m^2		
		Deduct for m	1	240.95	1.2		289	m^2		
		Total-pipeline portion					4703	m^2		
		Manholes portion	1				376	m^2		
		Total					5079	m^2		
		Say		5079.2	m^2		@	Rs	3633.5	18455293
		GST component						Rs	654.03	3321953
26		Interlocked tiled surfaces	1	840	1.2		1008	m^2		
		Deduct for manholes	1	48.65	1.2		58.38	m^2		
		Total-pipeline portion					949.62	m^2		
		Manholes portion	1				75.99	m^2		
		Total					1025.6	m^2		
		Say		1025.6	m^2		@	Rs	3747.1	3843059
		GST component						Rs	674.478	691751
27		Municipal roads	1	9748	1.2		11698	m^2		
		Deduct for manholes	1	564.60	1.2		678	m^2		

		Total-pipeline portion					11020	m^2		
		Manholes portion	1				882	m^2		
		Total					11902	m^2		
		Say		11902	m^2		@	Rs	2759.4	32842229
		GST component						Rs	496.692	5911601
28	OD	Providing steel sheet shoring to the sides of the trenches to depths of above 4.00 m but not exceeding 6.00m using 6 mm M.S. sheet 0.50 M wide stiffen on edges with 50 mm x 50mm x 6 mm M.S. angles driving down vertically on either side one after another in lines and levels with suitable pile driving equipment and accessories to a maximum depth of 0.50 M below the bottom of the proposed excavation 0.5 M above ground level suitably braced by horizontal walling pieces at 75 x 150 mm x 8 mm angles on either side at intervals not exceeding 1.50M and horizontal screw jack type struts at 1.50M intervals and maintaining the shoring till the pipes are laid and works are completed, dismantling, cleaning and restacking for reuse including all labour, hire charges and conveyance for equipment, tools and plants and sundries etc. complete.								
		For trenches above 2.0 m depth	1				2808.2	m^2		
		Total					2808.2	m^2		
		Say		2808.2	m^2		@	Rs	749.13	2103755
		GST component						Rs	134.84	378676
29	OD	Taking connection for manholes and chambers								
			2252	1			2252	Nos.		
		Total					2252	Nos.		
		Say		2252	Nos.		@	Rs	756.4	₹ 17,03,413
		GST component						Rs	136.152	₹ 3,06,614
30		Fencing one side of trenches, 1.50 m height with two rows of 10 cm plastic caution tape in vertical casuarina pole (girth 15cm to 24cm) fixed at 2 m intervals.								
			2	14798			29595	m		
		Total					29595	m		
		Say		29595	m		@	Rs	31.39	₹ 9,28,970
		GST component						Rs	5.65	₹ 1,67,215
31	19.18.3	560 mm diameter C.I. cover (heavy duty) the weight of the cover to be not less than 108 kg								
			563	1			563	Nos.		
		Total					563	Nos.		
		Say		563	Nos.		@	Rs	8021.1	₹ 45,15,880
								Rs	1461.5	₹ 8,22,868

		Total- Sewer network								₹ 19,03,16,567
		GST component								₹ 3,44,59,459

5.19 ECO-FRIENDLY UNITS AND OTHER SYSTEMS

ECO-FRIENDLY UNITS										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
a	Green Belt, Special Exterior Wall Garden and Landscaping									
			1	Nos.			@	Rs	1155000	1155000
		GST component						Rs	207900	207900
		Total- Eco-friendly units								₹ 13,62,900.00
b	Facility for Recycling Purposes									
			1	Nos.			@	Rs	150000	150000
		GST component						Rs	27000	27000
		Total- Facility for recycling purposes								₹ 1,77,000.00
c	Building with Trussed Roof and Eco-friendly walls									
		STP	1	Nos.			@	Rs	2810500	2810500
		Wells	2	Nos.			@	Rs	616000	1232000
		Total								4042500
		GST component						Rs	727650	727650
		Total- Building with trussed roof and eco-friendly walls								₹ 47,70,150.00
d	Equipment, Laboratory items, Furniture and Computer system for CIPS of IoT									
			1	Nos.			@	Rs	600000	600000
		GST component						Rs	108000	108000
		Total- Equipment, Laboratory items, Furniture and Computer system etc.								₹ 7,08,000.00
e	Supply and installation of steel cover slab prefabricated for equalisation tank									
			1	Nos.			@	Rs	200000	200000
		GST component						Rs	36000	36000
		Total- Equipment, Laboratory items, Furniture and Computer system etc.								₹ 2,36,000.00

5.20 MECHANICAL ITEMS

MECHANICAL ITEMS										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
1		Sewage transfer pump - Supply, Installation, Commissioning, testing and trial run of submersible sewage handling type pump, with specified discharge and head and of reputed make.								
		Power of pump required	7.5	HP	Q	19.52	LPS	H	12	m
			2	Nos.			@	Rs	207338.4	₹ 4,14,677
		GST component						Rs	37320.91	74642
2		Bar Screen-coarse- Supply and installation, of manual bar screen, MS – epoxy frame to be fitted in bar screen chamber of specified width, with MS flat bars and 20 mm c/c gap between bars. The frame to be mounted on the chamber and provided with MS rake arm with racks for removal of collected solids and trough to be provided for transfer of the collected solids. Flow Rate and height should be as specified. Angle of Inclination: 45 Degree, Spacing: 20mm								
		Width of screen channel-STP	0.75	m	Q	0.035	m^3/sec	H	1.2	m
		Width of screen channel-CTU	0.6	m	Q	0.005	m^3/sec	H	1.5	m
			2	No.			@	Rs	25000	₹ 50,000
		For lift stations	6	No.			@	Rs	25000	₹ 1,50,000
		Total								₹ 2,00,000
		GST component						Rs	₹ 36,000	36000
3		Bar Screen-fine- Supply and installation, of manual bar screen, MS – epoxy frame to be fitted in bar screen chamber of specified width, with MS flat bars and 20 mm c/c gap between bars. The frame to be mounted on the chamber and provided with MS rake arm with racks for removal of collected solids and trough to be provided for transfer of the collected solids. Flow Rate and height should be as specified. Angle of Inclination: 45 Degree, Spacing: 6mm								
		Width of screen channel	0.75	m	Q	0.035	m^3/sec	H	0.0350671	m
			1	No.			@	Rs	25000	₹ 25,000
		GST component						Rs	4500	4500
4		MBBR media- Supplying and fixing of non-clogging freely moving biomass media of polypropylene construction Sp. Gravity 0.93 for MBBR reactor with required specific surface area, length 10-20 mm, dia 20-25 mm complete as per technical specification or as directed by Engineer in Charge								
		Specific surface area of carrier			600.00	m^2/m^3				
			1		237.81	m^3	@	Rs	27500	₹ 65,39,720

		GST component						Rs	4950	1177150
5		Air Blower Supply, erection, testing and commissioning of twin lobe air blower for indoor application complete with acoustic canopy, air filter, motor of 1500 rpm , pulleys, pressure gauges, pressure relief valve, acoustic hood, suction silencer with suitable flanges, common motor and compressor base frame with motor belt tightening arrangement interconnecting line with flanges including all accessories complete as per technical specification or as Directed by Engineer in Charge.								
		Capacity of blower			2801.0	m^3/hour				
		Power of motor			52.00	HP				
			3				@	Rs	780000	₹ 23,40,000
		GST component						Rs	140400	421200
6		Bubble Diffuser for MBBR- Fine Bubble Diffuser Supplying and fixing of retrievable type fine bubble diffusers of 90mm dia,1500mm length, Ethylene Propylene Diene Monomer (EPDM) make with SStee1"x1",SS lifting hook 8 mm, SS foundation bolt 6 mm, SS C clamp suitable for 1"O.D, hose, PP Rope, PP swivel nut, PP sleeve, Silicone Washer, SS hos clamp, RCC block complete as per technical specification compatible for specified air flow								
			3				@	Rs	50000	₹ 1,50,000.0
		GST component						Rs	9000	27000
7		Air Grid Pipe Supply and installation of air pipes (HDPE) assembly into valves and other accessories as required for the blowers to various tanks as a complete unit								
			3				@	Rs	50000	₹ 1,50,000.0
		GST component						Rs	9000	27000
8		Tube settler media- Media to be of UV stabilized PVC material, hexagonal chevron shaped, 750mm height and about 1.0mm thick and with tongue and groove tube fitting. The plan settling area should be between 10 – 12 m^2/m^3 /day minimum at 60° slope. The media is to be provided along with lock nuts as required.								
		Total contact area	213.3		m^2					
			1				@	Rs	202635	₹ 2,02,635.0
		GST component						Rs	36474.3	36474
9		Electromagnetic Flow meter, pressure and quality sensors- Supply and erection of electromagnetic flow meter, pressure and quality sensors compatible to IoT and central control system with flow recorder, digital flow/quality/pressure indicator, flow/quality/pressure integrator with sensors, totaliser, transmittal and display arrangements and all accessories including housing arrangements, etc. complete to fix in the incoming pipeline to STP or at the Screen channel as directed by the Engineer in Charge								
			5				@	Rs	50000	₹ 2,50,000.0
		GST component						Rs	9000	45000
10		Filter feed pump - Supply, Installation, Commissioning, testing and trial run of submersible filtered water handling type pump, with specified discharge and head and of reputed make.								

		Power of pump required	17.50	HP	Q	18.70	LPS	H	35.00	m
			2.00	Nos.			@	Rs	402447.5	₹ 8,04,895
		GST component						Rs	72440.55	144881
11		Pressure Sand Filter- Supply, installation and erection, testing and commissioning of of Pressure Sand Filter - MS vessel construction. Filter to be of MS construction with multiport valve for operations. Suitable stand / support should be provided along with the filter. Filtration rate should not be greater than 12 m^3/hour/m^2 of the filtration area. Dirt loading capacity to be sufficient to initiate backwash once in 8 hours i.e. once / shift. Filter to have inlet and outlet piping, inlet and outlet for backwash and air vent. Sand filter to be fitted with pressure gauge at inlet and outlet. Sand filter main header is to be fitted with flow meter – turbine type / rotameter type with range up to minimum of 125% of the rated flow through the pipeline. Media to consist of graded pebble, coarse and fine sand. Depth of media to be as per recommendations provided in CPHEEO manual and all relevant IS Codes of practice. Cost includes supporting foundation.								
		Flow	67.33	m^3/hour	Diameter	2.7	m	H	2.5	m
			1				@	Rs	1650000	₹ 16,50,000
		GST component						Rs	297000	297000
12		Carbon Filter- Supply, Installation and erection, testing and commissioning of Activated Carbon Filter - MS composite vessel construction. Filter to be of MS construction with multiport valve for operations. Suitable stand / support should be provided along with the filter. Filtration rate should not be greater than 10 m^3/hour/m^2 of the filtration area. Filter to have inlet and outlet piping, inlet and outlet for backwash and air vent. Carbon filter to be fitted with pressure gauge at outlet. Media to consist of graded pebble, coarse, fine sand and activated carbon. Depth of media to be as per recommendations provided in CPHEEO manual. Activated carbon should be of high quality for removal of impurities and to be used for wastewater purification. Cost includes for foundation also.								
		Flow	67.33	m^3/hour	Diameter	3	m	H	2.5	m
			1				@	Rs	1900000	₹ 19,00,000.0
		GST component						Rs	342000	342000
		Total								₹ 22,42,000
13		Alum and Lime Dosing System- Supply, installation, commissioning and testing of Alum dosing tank having capacity 50 litre in LLDPE/ FRP/PP material and alum dosing electronic metering type pump of 1-3 LPH range with 2.5 bar working pressure								
			4				@	Rs	25000	₹ 1,00,000
		GST component						Rs	4500	18000
14		Hypo Dosing System - Supply, installation, commissioning and testing of Hypo dosing tank having capacity 50lit in LLDPE/ FRP/PP material and hypo dosing electronic metering type pump of 1-3lph range with 2 bar working pressure								
			2				@	Rs	30000	₹ 60,000
		GST component						Rs	5400	10800
15		Odour control unit for co-treatment unit and STP								

			2					@	Rs	30000	₹ 60,000
		GST component							Rs	5400	10800
16		Sludge transfer to thickener pump - Supply, Installation, Commissioning, testing and trial run of submersible sewage handling type pump, with specified discharge and head and of reputed make.									
		Power of pump required	1.00	HP	Q	1.56	LPS	H	15.00	m	
			2	Nos.				@	Rs	27645.12	₹ 55,290.24
		GST component							Rs	4976.12	9952
17		Sludge transfer to centrifuge pump of screw type - Supply, Installation, Commissioning, testing and trial run of submersible sewage handling type pump, with specified discharge and head and of reputed make.									
		Power of pump required	0.50	HP	Q	0.48	LPS	H	15.00	m	
			2	Nos.				@	Rs	13822.56	₹ 27,645.12
		GST component							Rs	2488.1	4976
18		Filter backwash pumps - Supply, Installation, Commissioning, testing and trial run of filter backwash pump, with specified discharge and head and of reputed make with all accessories.									
		Power of pump required	2.00	HP							
			2	Nos.				@	Rs	55290	₹ 1,10,580.4
		GST component							Rs	9952.2	19904
19		Filtrate cum dilution pump to equalisation tank									
		Power of pump required	1.00	HP							
			2	Nos.				@	Rs	27645.12	₹ 55,290.24
		GST component							Rs	4976.1	9952
20		Recycled water transfer pump for dilution tank									
		Power of pump required	3.50	HP							
			2	Nos.				@	Rs	96757.9	₹ 1,93,515.8
		GST component							Rs	17416.4	34833
21		Diluted septage transfer pump for STP									
		Power of pump required	3.50	HP							
			2	Nos.				@	Rs	96758	₹ 1,93,515.8
		GST component							Rs	17416	34833
22		Sewage transfer pump - Supply, Installation, Commissioning, testing and trial run of submersible sewage handling type pump, with specified discharge and head and of reputed make.									

		For lifting stations								
		LF-1	0.5	HP	Q	0.69	LPS	H	6	m
		LF-2	1	HP	Q	3.0	LPS	H	6	m
		LF-3	0.5	HP	Q	0.20	LPS	H	6	m
		LF-4	0.5	HP	Q	0.40	LPS	H	6	m
		LF-5	1.5	HP	Q	7.98	LPS	H	6	m
		LF-6	0.5	HP	Q	0.06	LPS	H	6	m
		From well to well	3	HP	Q	7.38	LPS	H	12	m
		Numbers	2							
		From well to STP	7.5	HP	Q	11.53	LPS	H	18	m
		Numbers	2							
							@	Rs	1700174.9	₹ 17,00,175
		GST component						Rs	306031.48	₹ 3,06,031
		Total								₹ 20,06,206
23		Supply and installation of centrifuge including foundation								
			2	Nos.			@	Rs	200000	₹ 4,00,000
		GST component						Rs	36000	72000
		Total								₹ 4,72,000
24		Supply and installation of mixing equipment for de-nitrification tank								
			2	Nos.			@	Rs	25000	₹ 50,000
		GST component						Rs	4500	9000
		Total								₹ 59,000
25		Supply of GPS fitted vacuum truck of capacity 3000 litres for septage management including de-sludging equipment and cleaning devices								
			2	Nos.			@	Rs	4500000	₹ 90,00,000
		GST component						Rs	810000	1620000
		Total								₹ 1,06,20,000
26		Piping, initial channel arrangements, bypass arrangements, steel ladder, framework and fire-fighting arrangements								
			1	Nos.			@	Rs	350000	₹ 3,50,000
		GST component						Rs	63000	63000
		Total								₹ 4,13,000
		Total-mechanical items								₹ 2,67,32,939
		Total-GST								₹ 48,11,929

5.21 ELECTRICAL AND INSTRUMENTATION WORKS

ELECTRICAL AND INSTRUMENTATION WORKS										
Item No.	Item Code	Description	No	L	B	H	V	Unit	Rate	Amount
1		Interconnecting piping system: • All process piping is to be in uPVC of approved ISI make, Class 2 minimum • All process valves to be in PP/PVC of Ball / Globe type• For valves in piping of ID > 150 mm, Butterfly valves are preferred • NRV should be provided at the common discharge header of all process pumps • Dosing lines to be in flexible Teflon / rigid PVC / HDPE. Detailed hydraulic analysis must be done for the system before supply and installation.								
			1	Nos.			@	Rs	450000	₹ 4,50,000
		GST component						Rs	81000	81000
		Total								₹ 5,31,000
2		ELECTRICAL & INSTRUMENTATION-Instrumentation items consisting of pressure gauges, level switches, electromagnetic flow meter, normal flow meter , pressure gauges, IoT based sensors, electrical panels – Powder coated MCC Panel shall be Non compartmentalized free standing floor mounted, dust and vermin proof, with reinforcement of suitable size angle iron, channel, T -iron flats as required. Panel shall be suitable for 415V, 3-Phase,50 Hz incomer. Switchgear components to include, but not limited to, MCCB for incomer and for each switchgear, suitable OLR and contactor provisions to be given as per guidelines of the Electrical authority. Panel to be fabricated based on the Motor Load List as given in the technical specifications AC: MS powder coated panel with switchgear components as per motor load list, fixed, floor mounted and non-compartmentalized pane. Interconnection cables – Outgoing feeders from AC panel to each prime mover will be based on CEIG guidelines. Cables to be suitably protected either through (a) PVC conduit or (b) armoured cables as appropriate Cabling includes glanding and termination for each prime mover. Cables should not be run on the ground or directly on the walls. Cables to be mounted on suitable runners / cable trays / PVC conduits as appropriate. All interconnecting cabling and glanding, termination accessories as per specifications.								
			1	Nos.			@	Rs	825000	₹ 8,25,000
		GST component						Rs	148500	148500
3		Supply, installation and commissioning of diesel generator								
			7	Nos.			@	Rs	120000	₹ 8,40,000
		GST component						Rs	21600	151200
4		Supply and installation of accessories for electrical connection and control units for lifting stations and collection wells including foundations								
		Lifting stations	6	Nos.			@	Rs	25000	₹ 1,50,000
		Collection wells	2	Nos.			@	Rs	75000	₹ 1,50,000
		Total								₹ 3,00,000
		GST component						Rs	₹ 54,000	₹ 54,000
5		Supply, installation and commissioning of solar units for lifting stations and collection wells								

			8	Nos.			@	Rs	20000	₹ 1,60,000
		GST component						Rs	3600	₹ 28,800
6		Supply, installation and commissioning of solar units for STP								
			1	Nos.			@	Rs	1000000	₹ 10,00,000
		GST component						Rs	180000	₹ 1,80,000

5.22ABSTRACT OF COST

ABSTRACT OF COST		
Sl. No.	ITEM	AMOUNT
CIVIL ITEMS		
1	Site Preparation-LS	₹ 5,000
2	OG Trap, Receiving Chamber, Screen, Grit Chamber	₹ 36,79,575
3	Equalisation Tank	₹ 38,30,105
4	Dilution Tank for Co-treatment	₹ 12,98,720
5	Moving Bed Biofilm Reactors	₹ 66,59,946
9	Clarifier with Tube/Plate Settler	₹ 13,04,007
10	Sludge Sump and Thickener	₹ 7,07,685
11	Chlorine Contact Tank and Filter Feed Tank	₹ 9,90,224
12	Treated Water Tank	₹ 7,58,410
13	Green Belt and Landscaping	₹ 11,55,000
14	Facility for Recycling Purposes	₹ 1,50,000
15	Building with Trussed Roof and Eco-friendly walls	₹ 42,42,500
16	Equipment, Laboratory items, Furniture and Computer	₹ 6,00,000
17	Sewer network with pipelines and chambers	₹ 19,03,16,567
	TOTAL OF CIVIL ITEMS	₹ 21,56,97,739
	GST Component (18%)	₹ 3,88,22,126
MECHANICAL ITEMS		
1	Gates and Screens	₹ 2,25,000
2	Pump sets and Aeration system	₹ 61,95,584
3	PSF & ACF	₹ 35,50,000
4	Centrifuge	₹ 4,00,000
5	Bypass arrangements, steel ladder and frame work	₹ 3,50,000
6	MBBR Carrier and other items	₹ 65,89,720
7	Tube settler media	₹ 2,02,635
8	Alum and Lime dosing systems	₹ 1,60,000
9	Odour Control Unit	₹ 60,000
10	GPS fitted Vacuum Trucks	₹ 90,00,000
	TOTAL OF MECHANICAL ITEMS	₹ 2,67,32,939
	GST Component (18%)	₹ 48,11,929
1		
1	Interconnecting piping system	₹ 4,50,000
2	Diesel Generator	₹ 8,40,000
3	Electrical works, IoT based sensor and control units	₹ 15,25,000
4	Electrical installations for lifting stations and collection wells	₹ 3,00,000
5	Installation of solar units for lifting stations, wells and STP	₹ 11,60,000
	TOTAL OF ELECTRICAL ITEMS	₹ 42,75,000

	GST Component (18%)	₹ 7,69,500
ABSTRACT OF COST		
Sl. No.	ITEM	AMOUNT
1	Civil Works	₹ 21,56,97,739
2	Mechanical Works	₹ 2,67,32,939
3	Electrical Works	₹ 42,75,000
	Total Project Cost	₹ 24,67,05,678
	GST Component (18%)	₹ 4,44,03,556
	DPR preparation charge @ 2.5%	₹ 61,67,642
	Centage charges@10%	₹ 2,46,70,568
	Unforeseen	₹ 556
	GRAND TOTAL	**₹ 32,19,48,000**
	(Rs. Thirty Two Crores Nineteen Lakhs Forty Eight Thousand Only)	
	Total O&M cost for 10 years	₹ 11,09,10,000
	TOTAL COST including 10 years O&M	**₹ 43,28,58,000**
	s. Forty Three Crores Twenty Eight Lakhs Fifty Eight Thousand Only)	

CHAPTER 6

OPERATION AND MAINTENANCE

6.1 GENERAL

For the success of a sewerage treatment system, it is inherent to note that meticulous operation and maintenance planning is the key. In the following sections various aspects of effective operation and maintenance, cost analysis, application of modern technologies for monitoring and process control and maintenance of an eco-friendly system are illustrated.

In engineering parlance, the term operation refers to the daily operation of the components of a sewerage system such as collection system, sewage pumping stations (SPS), pumping mains, sewage treatment plants (STP), machinery and equipment, etc., in an effective manner by various technical personnel, and is a routine function. The term maintenance refers to the art of keeping the structures, plants, machinery and equipment and other facilities in optimum working order and includes preventive maintenance or corrective maintenance of mechanical adjustments, repairs, and planned maintenance. However, replacements, correction of defects etc., are considered as actions excluded from preventive maintenance.

6.2 PLANNING FOR EFFECTIVE OPERATION AND MAINTENANCE

Three categories of variability that can affect the design, performance and reliability of a wastewater treatment plant are a) variability of the influent wastewater flowrate and characteristics, b) inherent variability in wastewater treatment processes and c) variability caused by mechanical breakdown, design deficiencies and operational failures.

It may be noted that effective use of the equalisation facility will balance most of the issues related with the variability of the influent flowrate and abnormal BOD levels at certain points of time. Many of the treatment units exhibit variability in performance despite the efficient planning and design. However, these problems can be eliminated at the design stage itself by adopting some conservative values. At the operational stage, some of the design deficiencies can be addressed by few additions in the system which will not affect the total operational cost. Occurrence of mechanical and electrical breakdown can be addressed by careful planning of maintenance activities. There is a provision for diesel generator back up and solar energy sources also can be relied upon.

It is recommended to form an internal monitoring committee for periodical inspection and control of activities related to the function, efficiency and operation of the STP. Help from Kudumbasree for support activities of monitoring and control can be sought.

Operation and maintenance for 10 years is to be performed by the firm who carries out the construction and commissioning of the STP.

6.3 TYPE OF MAINTENANCE

There are three types of maintenance of a sewerage system – preventive, routine and emergency. Preventive or routine maintenance should be carried out to prevent any breakdown of the system and to avoid emergency operations to deal with clogged sewer lines or overflowing manholes or backing up of sewage into a house or structural failure of the system. Preventive maintenance is more economical and provides for reliability in operations of the sewer facilities. Emergency repairs, which would be very rare if proper maintenance is carried out well, also, must be provided for. Proper inspection and preventive maintenance are necessary.

6.4 INSPECTION AND EXAMINATION OF SEWER

Sewer collection systems are intended to be a reliable method of conveying sewage from individual discharge to sewage treatment plants. Inspection and examination are the techniques used to gather information to develop operation and maintenance programmes to ensure that new and existing collection systems serve their intended purposes on a continuing basis. Inspection and testing are necessary to do the following:

• Identify existing or potential problem areas in the collection system,

• Evaluate the seriousness of detected problems,

• Locate the position of problems, and

• Provide clear, concise, and meaningful reports to supervisors regarding problems.

Two major purposes of inspection and examination are to prevent leaks from developing in the sewers and to identify existing leaks so they can be corrected. Due to age, deterioration of the material of the sewer by attack of hydrogen sulphide or other chemicals, settlement of foundations and leaking joints may result in the structural failure of the sewer. It takes a very long time from the onset of the first initial defect to the collapse of the sewer. A crack or a leaking joint will allow subsoil water and soil mixture to enter the sewer causing cavities around it leading to slow settlement of foundation and the eventual collapse of the sewer.

Very often soil with water is carried away below the bedding along the length of the sewer. The type of failures often gives a clue to the cause. A shear failure due to faulty foundation or movement of earth is a clean vertical break in the pipe or barrel. Excessive loading, either internally or externally, causes horizontal breaks. Breaks caused by internal pressure leads to cracks in the sewer while external overload causes the top of the pipe to be crushed. Regular inspection of the sewer can pinpoint the sewer that needs to be attended to before there is a complete failure or collapse. For preventing the above serious instances

of damages to the sewer system, the maintenance engineer should establish adequate inspection and examination programmes.

6.5 SEWER CLEANING

To operate and maintain a sewer collection system to function as intended, the maintenance engineer should try to strive towards the following objectives:

• Minimize the number of blockages per unit length of sewer, and

• Minimize the number of odour complaints. For this purpose, sewer-cleaning using hydraulic or mechanical cleaning methods needs to be done on a scheduled basis to remove accumulated debris in the pipe such as sand, silt, grease, roots and rocks. If debris is allowed to accumulate, it reduces the capacity of the pipe and blockage can eventually occur resulting in overflows from the system onto streets, yards and into surface waters. Roots and corrosion also can cause physical damage to sewers.

6.6 PROTECTION OF SEWER SYSTEMS

A sewer may get damaged if other facilities such as water pipe or electric cable work are done beside or at the cross-section of a sewer. Especially, fluctuations due to ground excavation (pile, underground water drops and pile method) may have a serious impact. To avoid damages of sewer, the maintenance engineer should do the following:

1. Collect all related information about the construction activities which are planned around the sewer location,

2. Advise appropriate construction methods to minimize impact for sewer, and

3. If necessary, request the concerned agencies to adopt the protective measures for sewer prior to the work commencement.

6.7 INSPECTION OF MANHOLES AND APPURTENANCES

Because they are part of the collection system, manholes require the same inspection and attention as the rest of sewer network. When located in streets, these structures are subject to vibrations and pounding by vehicle traffic. Manholes may settle at a different rate than connected sewer, creating cracks in sewer pipe joints. The objectives of manhole inspection are therefore, to determine the proper elevations or grades around the lid, to confirm that the lid is not buried, and to examine structural integrity (look for cracks) of the manhole and its functional capacity. The condition of the pipelines coming into a manhole may be known merely by observing the content and volume of flows from a specific direction.

Manhole inspection and examination are made by visually inspecting the condition of the cover and the internal parts. Manhole inspection should be carried out together with the inspection and examination of sewer. It is generally carried out together with the cleaning of the sewer. Before entering any manhole,

adequate safety measures should be taken in accordance with stipulations. Safety measures during the work should be formulated considering traffic safety, oxygen deficiency, poisoning due to toxic gas such as hydrogen sulphide and so on.

6.8 CLEANING OF MANHOLES

Manhole cleaning should be performed by the most appropriate work method that suits the actual conditions of the work location. In manholes at starting point, junction manholes and manholes at sharp curve of sewers, sand and silt get deposited and environmental problems such as foul odours occur. For this reason, periodic cleaning is necessary. Moreover, when large debris flows in, it should be removed immediately otherwise there is a possibility of an overflow accident, float-off and dispersion of cover. Manhole inspection should be generally carried out together with the cleaning of the sewer. The work on the silt and sand in the bottom part should be pursuant to cleaning of the sewer pipe, while the dirt on the sidewall should be cleaned by high-pressure jet washing vehicle.

6.9 SAFTEY PRACTICES

Sewer cleaning is an occupation that has an overall accident frequency rate that is relatively higher than any other industry. The employer has the responsibility of providing the worker with a safe place to work. Nevertheless, the worker has the overall responsibility and must ensure that it is a safe place to work. This can only be done by constantly thinking of safety and working safely. The worker has the responsibility of protecting not only himself, but also all other plant personnel or visitors by establishing safety procedures for the plant and then ensuring they are followed. He must train himself to analyse jobs, work areas and procedures from a safety standpoint and learn to recognize potentiality hazardous actions or conditions. When he recognizes a hazard, he must take immediate steps to eliminate it through corrective action. If correction is not possible, guard against the hazard by proper use of warning signs and devices / by establishing and maintaining safety procedures. As an individual, the supervisor can be held liable for injuries or property damage, which results from an accident caused by his negligence.

6.10 OPERATION AND MAINTENANCE OF LIFT STATIONS

In general, lift stations are invariably used in gravity sewer network where depth of cut of sewers poses a problem in high water prone areas. The procedure is to sink a wet well on the road shoulder or an acquired plot after the shoulder and divert the deeper sewer there. The submersible pump will lift the sewage and discharge it to the next online shallow sewer. This is a very useful practice in such locations. Equipment located in the wet well should be minimized, including suction and discharge valves, check valves, or other equipment that require routine, periodic maintenance.

6.11 OPERATION AND MAINTENANCE OF PUMPING STATIONS

Pumping machinery is subjected to wear & tear, erosion and corrosion due to its nature of functioning, and therefore it is vulnerable to failures. Generally, failures or interruptions are mostly attributed to

pumping machinery rather than any other component. Therefore, correct operation and timely maintenance and upkeep of pumping stations and pumping machinery are of vital importance. Sudden failures can be avoided by timely inspection, follow up actions on observations of inspection and planned periodical maintenance. Downtime can be reduced by maintaining inventory of fast moving spare parts. Obviously due attention needs to be paid to all such aspects for efficient and reliable functioning of pumping machinery.

6.11.1 OPERATION OF PUMPS

The following points should be observed while operating the pumps.

A. Dry running of the pumps should be avoided.

B. Centrifugal pumps if installed with negative suction should be primed before starting.

C. Pumps should be operated only within the recommended range of the head-discharge characteristics of the pump.

• If pump is operated at a point away from duty point, the pump efficiency normally reduces.

• Operation near the shut-off point should be avoided, as it causes substantial recirculation within the pump, resulting in overheating of sewage in the casing and consequently, overheating of the pump.

D. As far as possible positive suction is to be provided to avoid priming during design itself.

E. Voltage during operation of the pump-motor set should be within ±10 % of the rated voltage. Similarly, current should be below the rated current shown on the name plate of the motor.

F. When parallel pumps are to be operated, the pumps should be started and stopped with a time lag between two pumps to restrict change of flow velocity to minimum and to restrict the dip in voltage in the incoming feeder and should be adequate to allow the pump head to stabilise.

G. When the pumps are to be operated in series, they should be started and stopped sequentially, but with minimum time lag. Any pump next in sequence should be started immediately after the delivery valve of the previous pump is even partly opened. Due care should be taken to keep open the air vent of the pump next in sequence, before starting that pump.

H. The stuffing box should allow a drip of leakage to ensure that no air passes into the pump and that the packing gets adequate wetness for cooling and lubrication. When the stuffing box is sealed with grease, adequate refill of the grease should be maintained.

I. The running of duty pumps and standby pumps should be scheduled so that no pump remains idle for a long period and all pumps are in ready-to-run condition. Similarly, the running schedules should be ensured so that all pumps do not wear equally needing simultaneous overhaul.

J. If any undue vibration or noise is noticed, the pump should be stopped immediately and the cause for vibration or noise should be checked and rectified.

K. Generally, the number of starts per hour shall not exceed four. Frequent starting and stopping should be avoided as each start causes overloading of motor, starter, contactor and contacts. Although overloading lasts only for a few seconds, it reduces the life of the equipment.

6.12 SMART MANAGEMENT AND ONLINE MONITORING USING INTERNET OF THINGS (IoT)

Advancement in the field of digital technology has enabled the wastewater treatment system operators and managers to control and enhance the performance of various components of the system. Internet of things (IoT) consists of a network of physical objects using various sensors as end points to enable monitoring from a remote station.

For the sewerage treatment plant, a network of various sensors can capture the variations of values of parameters like temperature, dissolved oxygen, chemical composition, TDS etc. at different control points of the system. The continuous data obtained through IoT is used by a customised algorithm for synthesis to impart a decision-making procedure. A centralised information processing system (CIPS) can be formed for this task. In addition to this smart water flow meters can also be coupled to this digital environment. IoT in wastewater management can also be used to calculate residual chemicals after the treatment. This data can be further used to calculate the efficiency of the treatment process and ensure that water quality standards are met before it is discharged in a water body.

By using real-time data gathered through different embedded sensors, performance characteristics of machines can be monitored that further increase the productivity of equipment and boost maintenance tasks. In the present study for the municipality, provision for implementing an IoT based control of the units have been suggested.

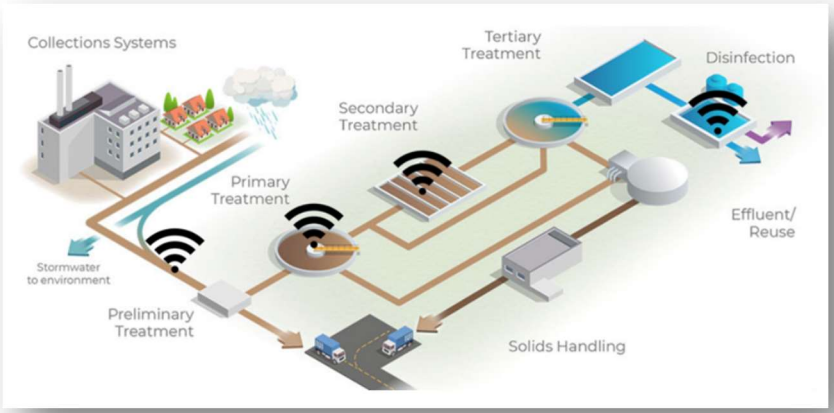


Fig.25 The continuous data obtained through IoT is used by a customised algorithm for synthesis to impart a smart decision-making procedure (photo courtesy-google)

6.13 ODOUR CONTROL METHODS

Odours are a complex combination of a wide variety of compounds; however, there are certain compounds and groups of compounds that contribute specifically to sewage odours, and significantly determine the selection of the control technology. These include the following:

• Hydrogen sulphide, and

• Ammonia.

Odour control is a complex and time-consuming challenge, often requiring a combination of methods for treating odorous gases and for removing or reducing the potential causes of the odours. If an odour problem is severe enough to affect the community, an emergency response and solution to the problem must be carried out quickly. The approach for selecting an odour control method or technology includes the following steps:

A. Identify the odour source and characteristics through sampling and analysis.

B. List and assign priorities to controlling a specific odour problem, recognizing considerations such as cost, plant location, future upgrading of various sewage processes, severity of the odour problem, and the nature of the affected area.

C. Select one or more odour control method or technology for implementation to meet the objectives of steps “a” and “b”, taking into consideration the advantages and disadvantages of each.

D. Monitor odour emissions from the treated air for process adjustments and for feedback to evaluate the solution’s effectiveness.

Hydrogen sulphide (H2 S) is the most common odorous gas found in sewage collection and treatment systems and results from the reduction of sulphate by bacteria under anaerobic conditions. Its characteristic rotten-egg odour is well known. The gas is corrosive, toxic and soluble in sewage. Hydrogen sulphide is considered a broad-spectrum poison, meaning it can poison several different systems in the body.

6.13.1 PREVENTION OF ODOUR

Hydrogen sulphide production can be controlled by maintaining conditions that prevent the build-up of sulphides in the sewage. The presence of oxygen at concentrations of more than 1.0 mg/L in the sewage prevents sulphide build-up because sulphide produced by anaerobic bacteria is aerobically oxidized. Maintaining an aerobic environment inhibits the anaerobic degradation process, which contributes to the generation of hydrogen sulphide. A checklist is given below:

• Prevent corrosion in the collection well of the facility by blowing air through the facility

• Avoid storing screenings and grit generated in the grit chamber for a long time. Dispose of screenings and grit at appropriate intervals

• Retention time of sludge in the sludge treatment facilities should be appropriate (Do not retain sludge for a long time)

• Maintain sewage at neutral pH range because most of the sulphide is present at a pH value of less than 7.

Following is a short checklist of operational considerations for controlling odours of primary treatment facilities: (May also apply in other facilities)

• Remove scum routinely, with increased frequency during warm weather.

• Remove sludge before it can bubble or float.

• Wash weirs and other points where floatable and slime collect. Some facilities use submerged pipes with holes rather than effluent troughs. The submerged pipes do not splash the primary effluent, thereby reducing the release of hydrogen sulphide.

• Wash down all spills and grease coatings.

• When draining a tank, immediately flush it completely. If sludge does not drain quickly, spray lime, calcium hypochlorite, or potassium permanganate on the sludge surface to reduce odours. Because even a clean tank can produce odours, flushing the tank with a chlorine solution or keeping the tank floor covered with a low concentration of chlorine solution will reduce odours.

• If the sewage is septic, add chemicals in the collection system or at the plant, as appropriate, to reduce sulphides.

• If tanks are covered for odour control, keep plates and access hatches in place.

• Routinely check any odour scrubbers or deodorizers for plugging, adequate supply of chemicals, proper pressures for demisting, and/or effectiveness of carbon.

• The splashing of primary sewage into weir troughs and effluent channels can result in the release of hydrogen sulphide. If possible, try to minimize the splashing of primary sewage into the channel or weirs. If it cannot be accomplished operationally, then installing submerged sewer pipes may be necessary. This will require tank modifications to verify the plant hydraulics and provide proper control to avoid fluctuations in the tank levels.

• Minimize the stripping of hydrogen sulphide from the sewage when using channel air diffuser systems. Adoption of the following regular practices will not only increase removal efficiency but will provide better working conditions for the operator:

• Regularly remove accumulations from the inlet baffles and outlet weirs with a hose or a broom with stiff bristles. Only experience will determine the necessary frequency.

• Clean scum removal equipment regularly; otherwise, obnoxious odours and an unsightly appearance will result.

• Keep cover plates in place except when operations or maintenance require their removal.

• Immediately flush and remove all sewage and sludge spills. Avoid hosing down motors and enclosed control devices.

• Establish a housekeeping schedule for the primary treatment area, including galleries, stairwells, control rooms, and related buildings, and assign responsibility for each item to a specific employee.

• Repaint surfaces as necessary for surface protection and appearance.

6.13.2 CONTROL OF ODOUR BY CHEMICAL ADDITION

Chemical addition can control odours in STP by preventing anaerobic conditions or controlling the release of odorous substances.

Chemical	Effective against
Oxidizers	
Ozone	Atmospheric hydrogen sulphide only
Hydrogen peroxide	Hydrogen sulphide, also acts as oxygen source
Chlorine	Hydrogen sulphide and other reduced sulphur compounds
Sodium and calcium hypochlorite	Hydrogen sulphide and other reduced sulphur compounds
Potassium permanganate	Hydrogen sulphide and other reduced sulphur compounds

Table 15 Control of odour by chemical addition

6.14 MAINTAINING AN ECO-FRIENDLY SYSTEM

In the proposed system of sewerage treatment, care has been taken to treat the sewage and sullage effectively and efficiently to protect the environment. Hence the natural water sources are also benefitted, and a portion of the recycled water can be used for toilet flushing, gardening etc. Since the treated water contains plant nutrients also, it will be beneficial for the environment when discharged as soil infiltration. Care has also been taken to properly treat the sludge produced during the operation. It may also be noted that a septic tank complying with the Indian Standard Code of practice has been designed and given at the initial treatment stage to reduce any shock of load to the biological treatment units.

It has also been decided to impart a green environment to the STP units with special methods of growing plants at the exterior of plant components and space between units. Maximum utilisation of space has been taken at the planning and design stage itself and using the natural treatment properties of the soil, such decentralized systems provide good opportunities to use the natural environment. They can help reduce the level of difficulty and cost to treat pollutants, such as nutrients, and keeping them from entering lakes, rivers, and streams.

Some aspects of the green landscaping eco-friendly unit management are described below for the proposed STP:

Soil: The soil acts as a natural filter and provides final treatment by removing harmful bacteria, viruses, and nutrients.

Odour management: Special attention is also given to proper odour management by using green belt inspired landscaping and chemical application whenever needed at extreme cases.

Trees: barrier formed with fast growing trees are planned for protection against pollution, for defining boundaries and for assisting in the creation of beautiful landscaping. Some of the plants are Casuarina Equisetifolia, golden bamboo, Grevillea Robusta etc.

Shrubs: the use of shrubs in the mass as a basic constituent in the planning of landscape is important. Shrubs with properties of hardiness, vigorous growth and an emphasis on evergreen plants are selected.

Creeping plants for exterior of units: plants like climbing hydrangea attaches itself to walls and grow to impart a green environment.

Air purifying plants: Polluted air contains particles, odours and harmful gases like nitrogen oxides, sulphur dioxide and ammonia. These pollutants settle on the leaves of trees and plants. The leaves and plant surface absorb these pollutants and through their stomata (pores) and filter these harmful substances from the air. Trees also trap heat and reduce greenhouse gases in the atmosphere. They also reduce the ground level ozone level and enrich the air around us with life giving oxygen. For combating a variety of respiratory troubles and other illnesses caused by air pollution, there can be no better way than planting some chosen varieties of plants that can cleanse the air and make our environment better.

The bamboo palm is a popular purifying houseplant due to its tropical look and insect-repelling quality. The bamboo palm can remove substances like benzene, formaldehyde, chloroform, carbon monoxide, and xylene.

6.15 OCCUPATIONAL HEALTH HAZARDS AND SAFTEY MEASURES

The sanitation workers, engaged in operation and maintenance (O&M) of sewerage system or septic tanks, are exposed to different types of occupational hazards like injuries caused by physical actions, chemicals contacts, infections caused by pathogenic organisms, and dangers inherent with oxygen

deficiency, hydrogen sulphide, and combustible gases. The employers are obligated to provide their employees with safety equipment or protective gears as well as cleaning devices and ensure observance of safety precautions appropriate for each hazardous condition to reduce the employees' risks to health and safety. Moreover, to guard against human error and carelessness, proper safety training and adequate effective supervision by safety personnel are most essential.

The GOI enacted the "Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act, 1993," which declared the employment of scavengers or the construction of dry latrines to be an offence, considering the foregoing, another bill titled "The Prohibition of Employment as Manual Scavengers and their Rehabilitation Bill, 2013" was introduced in the Parliament in September 2013 and has since been passed. The Bill aims to eliminate manual scavenging and insanitary latrines and provides for proper rehabilitation of manual scavengers in alternative occupations so that they can lead a life of dignity. In addition to the Acts mentioned above, employees shall follow "Contract Labour Regulation and Abolition Act, 1970" for secure operational health and safety at their sites. O&M of sewerage facilities, which should not be discontinued at any moment, requires health and safety consciousness equal to or greater than one that is needed for construction projects. In India, "health and safety policy" is defined in construction project management by Bureau of Indian Standard (BIS). Therefore, the same health and safety policy for construction projects may also be adopted for O&M of sewerage facilities. STPs are subject to safety audits, which confirm the status of safety and health organizational setup, education / training, provision / inspection of personal protection, and records of safety, to ensure occupational safety and health at the work sites. The plant engineer should rectify failures immediately, if any. The audit shall be implemented as per IS: 14489 "Code of Practice on Occupational Safety and Health Audit." Standard safety audit procedures of the inspectorate of factories shall be at a frequency of a month and compliance reported to that agency.

1.16 COST ANALYSIS

OPERATION & MAINTENANCE COSTS					
Sl. No.	Item	Rate	Nos.	Unit	Expenditure
1	Power Charges for STP @ Rs. 7.2 for kwh @	71399.2		kwh/month	5,14,074
2	Power Charges for network @ Rs. 7.2 for kwh @	6848.3		kwh/month	49,308
3	Operators rate/month-STP	25000.0	3	Nos.	75,000
4	Operators rate/month-Wells	15000.0	3	Nos.	45,000
5	Fitter rate/month-STP	20000.0	1	Nos.	20,000
6	Driver for septage handling vehicle/month	20000.0	2	Nos.	40,000
7	Cleaner for septage handling vehicle/month	15000.0	2	Nos.	30,000
8	Fuel for generator/month				20,000

	Fuel for vehicle/month@150 km/day for both vehicles	1425			42,750
9	Gas Chlorine/month				5,000
10	Alum and Lime dosing/month				7,500
11	Chemicals for odour management/month				7,500
12	Chemicals for lab tests/month				5,000
13	Spares and replacements/month				5,000
14	Network routine inspection, flushing, cleaning including for manholes/month@	1% of cost of network/year			2,37,896
	Total per month				11,04,028
	Total per month excluding power charges				5,40,646
	Annual Operation & Maintenance Charge				1,32,48,333
	Annual Operation & Maintenance Charge excluding power charges				64,87,748
	Treatment Cost per Day				36,297
	Unit Cost of Treatment per Kilo Litre				27
10 YEAR ANNUAL O&M COST CONSIDERING 8% ANNUAL INCREASE EVERY YEAR					
Excluding power charges					
1	1st year				₹ 64,87,748
2	2nd year				₹ 70,06,768
3	3rd year				₹ 75,67,310
4	4th year				₹ 81,72,695
5	5th year				₹ 88,26,510
6	6th year				₹ 95,32,631
7	7th year				₹ 1,02,95,242
8	8th year				₹ 1,11,18,861
9	9th year				₹ 1,20,08,370
10	10th year				₹ 1,29,69,039
	Total O&M cost for 10 years				₹ 9,39,85,174
	GST @ 18%				₹ 1,69,17,331
	Unforeseen charges				₹ 7,495
	Total O&M cost for 10 years including GST				**₹ 11,09,10,000**

CHAPTER 7

CONCLUSIONS

7.1 OBSERVATIONS FROM ANALYSIS

From the analysis performed for the Wadakkanchery Municipality, Thrissur with respect to the planning designing and implementation of a sewerage system, it can be observed that both the Local Body and the society mutually benefits substantially once the project is realised. Adopting a meticulous operation and maintenance plan, the system can be successfully run for a longer period without experiencing any troubles. Since there are many innovative digital technologies for controlling the performance of the system, it is an easy task for the institution to own and run the sewerage system. This will also pave the way for a wider acceptance in the society for decentralised sewerage system applications. Adopting non-conventional energy sources like solar energy, it will be an easy affair to run many of the low-capacity pump sets. Also, a building envelope with eco-friendly materials and construction technologies will give an aesthetically pleasing and healthy system.

7.2 INSTITUTIONAL ARRANGEMENTS

Kerala Water Authority (KWA) has set up four sewerage circles under the sewerage vertical concept recently. The idea and vision behind it are to visualize and materialize complete sewerage schemes for the State. The Sewerage Circle, Thrissur has been assigned the task of preparation of Detailed Engineering Report (DER) for the Districts of Thrissur, Palakkad and Malappuram. The Project Planning and Development wing (PPD), Kochi has been given the additional charge of Sewerage Circle, Thrissur at present.

It is imperative that the institutional structures for the delivery of sewerage services are streamlined. The urban sanitation sector can learn from counterpart rural area programming such as Total Sanitation Campaign (TSC), National Rural Health Mission (NRHM), Sarva Shiksha Abhiyan (SSA), Integrated Child Development Services (ICDS) in establishing such institutional structures with clearly laid out roles and responsibilities. Until Local Self Government Institutions LSGI's develop their robust capacities, it is desired that the technical support is extended in planning, designing, implementation and O&M of sanitation services by other departments. Active involvement of local NGOs, community organizations, self-help groups of women will be ensured through awareness creation and community mobilization for increased ownership of the overall sanitation agenda at the local level. Promotion of active support to specially formed groups at the Ward level with primary focus in eliciting women participation will be paramount to the achievement of the goals of the State Sanitation Strategy.

7.2.1 DISRTICT LEVEL APPROACH

At each district level, water and sanitation mission headed by the District Collector is constituted and all officials pertaining to the sewerage planning and implementation process can contribute to the

achievement of complete coverage for the district. District level monitoring committee can also be formed with involvement of representatives of beneficiaries and local bodies. District level offices of KWA can closely associate with the district level sewerage activities of district administration.

7.2.2 URBAN LOCAL BODY (ULB) LEVEL APPROACH

A multi stakeholder comprising of representatives from shops and establishments, sanitary workers unions, educational institutions, women groups, contractors, NGO's, line departments, political and eminent personalities to be led by the Mayor/Chairman/Chairperson along with the Executive head of the ULB shall be constituted. The City Sanitation task force shall be duly supported by a City Sanitation Cell (CSC) that is staffed with relevant human resources. The cell shall be responsible for preparation and implementation of the city sanitation plan.

7.3 PLANNING FOR IMPLEMENTATION

It can be observed that for the perspective of Kerala in social conditions, status of urbanisation, public health issues and environmental characteristics, habitations can be divided into several zones of smaller strength of population for planning and implementing effective sewerage schemes. Hence a decentralised approach is beneficial.

The decentralized sewerage concept implies localized collection and localized treatment of excreta and sullage in micro zones within a major habitation keeping it in tandem with densification and progressively duplicating it as and when other micro zones densify. It will ensure that every micro zone owns up its excreta and sullage management and cannot expect a faraway habitation to receive and inherit it - a prospect which will sooner or later lead to inter conflicts and destabilize progress. Thus, the provision of both the collection system and treatment can be made compatible to the pace of development by juxtaposing on site sanitation as well in its fold.

As described in detail in the previous sections, GIS can be generously made use for the initial planning stages. Several factors influencing the sewage production characteristics and its carriage towards a desirable site for treatment and disposal can be meticulously planned using data analysis with the help of versatile applications of GIS.

In general, prediction of sewage volumes is far easier in decentralized sewerage micro collection areas and to that extent the design becomes realistic. Flows in a decentralized sewerage are relatively smaller than conventional sewerage and this implies that environmental damages from any mishaps are also minimal. Given the smaller flows, the sewer sizes are also smaller, and the depths of cut are also lesser thus making it easy to construct and maintain. Additions of newer service areas are independent of the existing system and the need to augment or enlarge the existing sewers and STPs are avoided. The STPs are smaller, and it is easier to find the reuse prospects nearby as compared to all the sewage being treated in one far corner. It is also easier to lay out return lines of treated sewage for use in medians, industrial supplies, flushing far flung head manholes, etc. The ecology of rivers, streams and receiving waters are better managed by smaller volumes of discharges of treated sewage at multiple locations than one

massive volume in a single location and if the single STP is out of order, the entire stretch of the water course gets polluted.

7.4 DATA INFORMATION AND MANAGEMENT

Accurate and reliable data information and management is a prerequisite for successful operation and maintenance of sewerage systems. As far as KWA is concerned, every district can have a district office with effective subunits for multi-pronged activities in data analysis and decision making. Modern technologies can be utilised for upgrading the existing systems and informed decision-making process can be sorted out for maintaining desirable level of performance of sewerage schemes.

Similarly, it may be noted that LSG officials are to be trained to make latest state of art maps of adequate resolution (1:10,000 and better) and uses WGS84 (World Global System 1984) as the datum for all their spatial information. Such an information system shall make best use of the GIS and MIS platforms that are rapid to access and retrievable for use in planning for urban and rural infrastructure, creates compatible data formats and transforms MIS information (e.g. for property mapping, census etc.) into spatial geo-referenced GIS files for further analysis and interpretation for all the important sectors (e.g. water, waste water, solid waste, storm water).Since ULBs and other LSG's have the final responsibility for ensuring all service delivery of sanitary and environmental outcomes, it is necessary that the state is refining and complementing existing national standards wherever adaption to the regional settings is required if and when required.

7.5 ENVIRONMENTAL IMPACT MANAGEMENT

The project area is not falling under environmental sensitive zones. There are no natural reserve forests or parks or the presence of coastal belt.

During the construction phase, the emissions from movement of vehicles used for project activity may affect the air quality due to the particulate matter generated during loading, transporting, unloading of materials during construction. Movement of heavy vehicles and concrete mixer would generate considerable noise in the surrounding environment. Hence a proper traffic management plan is recommended during the construction activities.

Sludge generated in the STP must be properly disposed off by transforming it into fertilizer products or bricks for low impact construction activities. Recycled water generated from the STP is to be used as per the guidelines already given.

Regarding the positive impacts, it is to be noted that water quality of the rivers and streams will be greatly improved along with the general environment. The large quantity of recycled water will be useful for multiple purposes including agriculture.

7.6 GENDER EQUALITY AND SOCIAL IMPLICATIONS

The project is envisaged to provide substantial improvements in the life of the people belong to the project area, especially for the womanhood. During the operation of the STP and the sewer network, the ULB can form a special monitoring group comprising of dedicated workforce especially from "Kudumbasree" units or similar groups for continuous appraisal of the sewerage scheme and subsequent upgradations. There must be special programmes organised for capacity building of the beneficiaries and all workforce associated with the operation and maintenance of the sewerage project.

7.7 FINANCIAL PLANNING AND OUTCOMES

It may be noted that overall costs (capital and operating) and financial sustainability must be determined to arrive at the most optimum solution. Hence during the detailed engineering survey and investigations stage these factors are to be considered for better performance of the system.

Fig.26 Capital cost planning

Fig.27 Operating cost planning

The Disability-Adjusted-Life-Years (DALY) is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death. Originally developed by the WHO, it is becoming increasingly common in the field of public health and health impact assessment (HIA). It extends the concept of potential years of life lost due to premature death – to include equivalent years

of ‘healthy’ life lost by virtue of being in states of poor health or disability. In doing so, mortality and morbidity are combined into a single common-matrix.

As per the WHO report, 80% of the diseases in human being are water-borne and water-related. It is mainly due to water pollution or water contamination and water logging. Though water logging may be location and weather specific, but water pollution and contamination is a common phenomenon which can occur at any place at any point of time if community is not careful about adverse impact of indiscriminate disposal of sewage. The indiscriminate disposal of human excreta or sewage from habitations may contain hazardous micro-organisms (pathogens) for water pollution and harbouring vectors which act as carriers of pathogens. Improvements in water supply and sanitation including management of municipal solid waste can substantially reduce the incidences and severity of these diseases, as well as infant mortality associated with diarrhoea.

From the above statements, it is evident that environmental pollution by liquid and solid wastes adversely affects the environment and human health directly or indirectly resulting in loss of life and heavy financial burden on exchequers.

7.8 ACTION PLAN FOR IMPLEMENTATION

The following sequence of implementation plan for the institution may be more effective in realising the goals of providing the sewerage system.

Priority	Plan
I	Preparation of a detailed engineering report
II	Appraisal of the report
III	Sanction of the project
IV	Fund mobilisation
V	Invitation of Tender for work
VI	Execution of work
VII	Formation of monitoring committee
VIII	Regular maintenance
IX	Assessment of performance
X	Modifications in process/unit operations

Table 16 Action plan for implementation

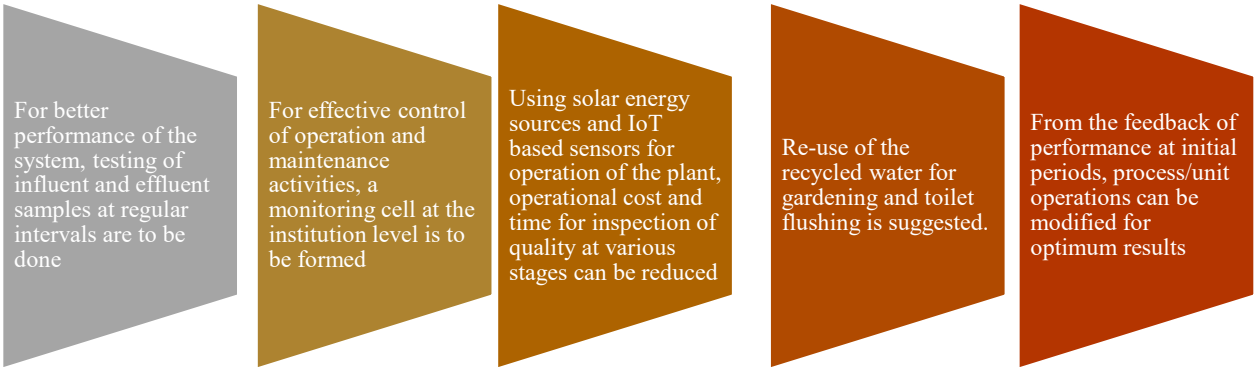
7.8.1 IMPLEMENTATION SCHEDULE

Sl. No.	Activity	Oct-Nov 2021	Dec-Jan 2021-22	Feb-Mar 2021	Apr-May 2022	Jun-Jul 2022	Aug-Sept 2022	Oct-Nov 2022	Dec-Jan 2022-23	Feb-Mar 2023	Apr-May 2023	Jun-Jul 2023	Aug-Sept 2023
1	Basic planning and discussions with government departments												
2	Survey on Related Plans												
3	Survey on Existing Facilities												
4	Survey on Resources of Sewerage System and its Utilization												
5	Finalization of design and detailed engineering report												
6	Appraisal of the report												
7	Sanction of the project												
8	Fund mobilisation												
9	Implementation												
10	Trial and commissioning												

Fig.28 Implementation schedule

7.9 RECOMMENDATIONS

The success of the system largely depends upon the commitment and attitude of the people benefitted from it and hence it is inherent that the Local Body will investigate every detail of the sewerage treatment plant and its supporting units to render a model of its kind in the State. Some of the points of action to be taken to enhance the performance of the system are outlined as follows:



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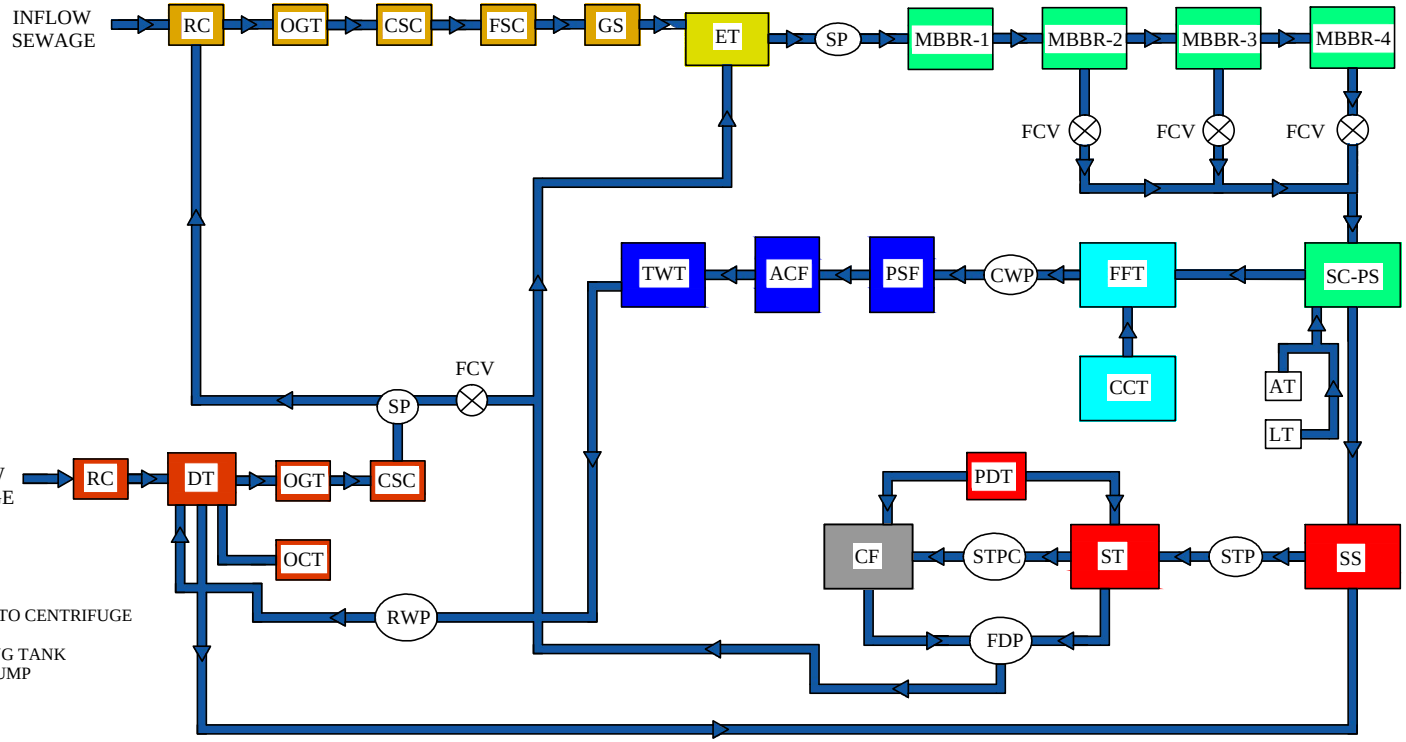
Annexure I

SCHEMATIC DIAGRAM



TWT- TREATED WATER TANK
SS - SLUDGE SUMP
STP- SLUDGE TRANSFER PUMP
ST - SLUDGE THICKENER
STPC - SLUDGE TRANSFER PUMP TO CENTRIFUGE
CF - CENTRIFUGE
PDT - POLY ELECTROLYTE DOSING TANK
FDP- FILTRATE CUM DILUTION PUMP
DT- DILUTION TANK
OCT - ODOUR CONTROL UNIT
FCV- FLOW CONTROL VALVE
RWP - RECYCLED WATER PUMP
SP - SEWAGE PUMP
MBBR-1 - MOVING BED BIO FILM REACTOR FOR BOD REMOVAL
MBBR-2 - MOVING BED BIO FILM REACTOR FOR NITRIFICATION
MBBR-3 - MOVING BED BIO FILM REACTOR FOR DE-NITRIFICATION
MBBR-4 - MOVING BED BIO FILM REACTOR FOR BOD REMOVAL AFTER DE-NITRIFICATION
SC-PS - SECONDARY CLARIFIER WITH PLATE SETTLER
FFT- FILTER FEED TANK
AT - ALUM TANK
LT - LIME TANK
CCT - CHLORINE CONTACT TANK
CWP - CLARIFIED WATER PUMP
PSF - PRESSURE SAND FILTER
ACF -ACTIVATED CARBON FILTER
RC- RECEIVING CHAMBER
OGT- OIL AND GREASE TRAP
CSC - COARSE SCREEN CHANNEL
FSC - FINE SCREEN CHANNEL
GS- GRIT SEPARATOR
ET - EQUALISATION TANK

KERALA WATER AUTHORITY
SEWERAGE CIRCLE THRISSUR

PREPARED BY: SEWERAGE CIRCLE THRISSUR	
AE. GIRANCHANDRAN A C	
AEE. PRIYADARSHINI B	
EE . SHYJU P THADATHIL	
SE . JAMAL P	

SCALE :
DATE: 28-12-2021

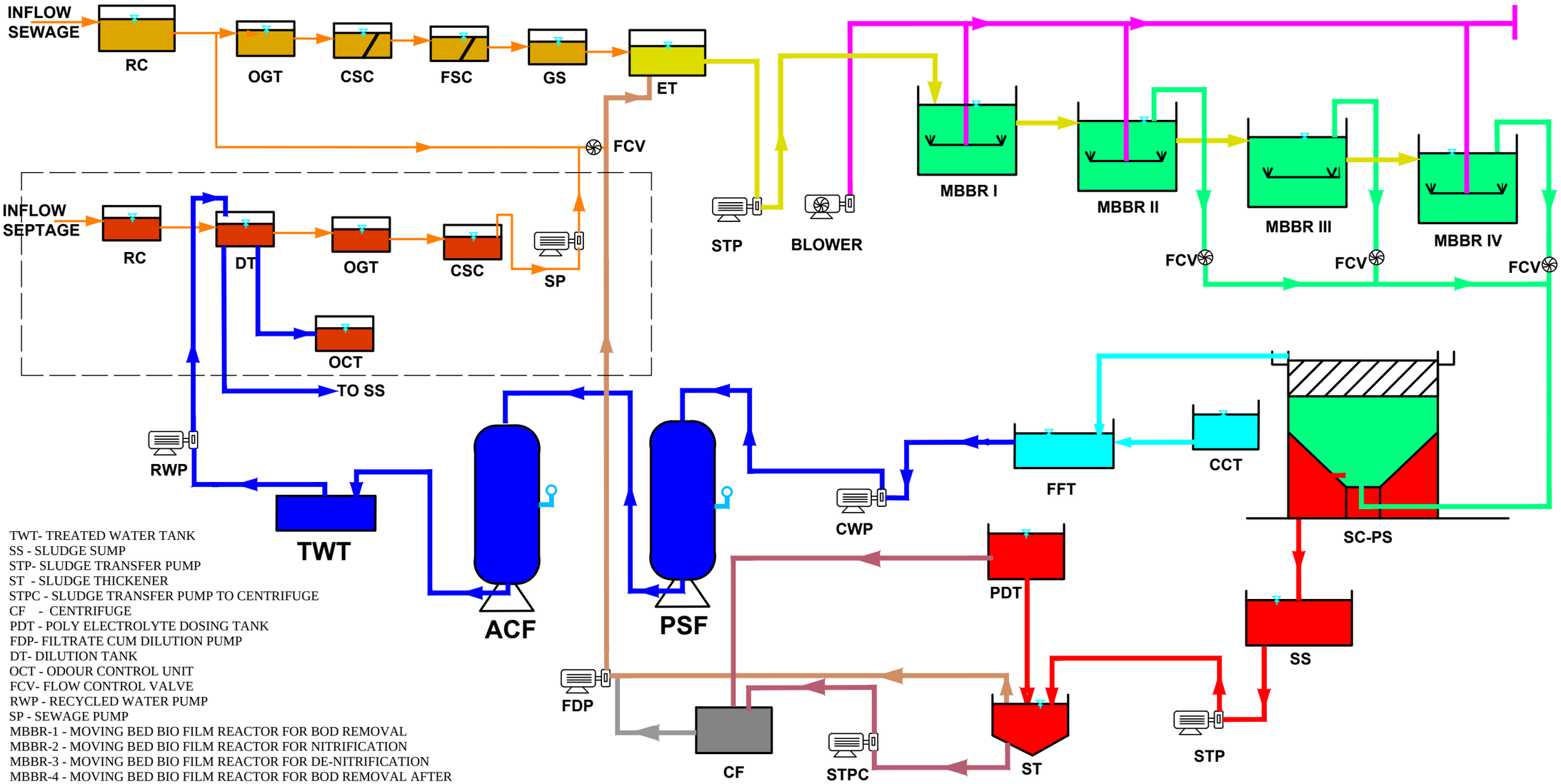
1.35 MLD CAPACITY SEWERAGE SYSTEM FOR WADAKKANCHERY MUNICIPALITY

TITLE : SCHEMATIC DIAGRAM

FILE NO : PPD/TSR/SEW-3/2021
DRAWING NO :

Annexure II

UNIT OPERATIONS AND PROCESS FLOW DIAGRAM



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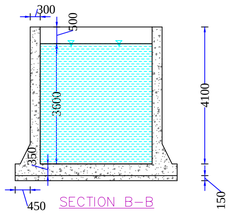
OGT- OIL AND GREASE TRAP
CSC - COARSE SCREEN CHANNEL
FSC - FINE SCREEN CHANNEL
GS- GRIT SEPARATOR
ET - EQUALISATION TANK

	KERALA WATER AUTHORITY SEWERAGE CIRCLE THRISSUR	**PREPARED BY: SEWERAGE CIRCLE THRISSUR** AE. GIRANCHANDRAN A C AEE. PRIYADARSHINI B EE . SHYJU P THADATHIL SE . JAMAL P
SCALE : DATE: 28-12-2021	**1.35 MLD CAPACITY SEWERAGE SYSTEM FOR WADAKKANCHERY MUNICIPALITY** TITLE: UNIT OPERATIONS AND PROCESS FLOW DIAGRAM	FILE NO : PPD/TSR/SEW-3/2021 DRAWING NO :

Annexure III

COMPONENTS DRAWINGS - STRUCTURAL



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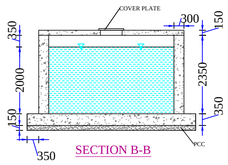

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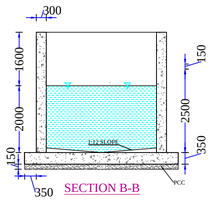

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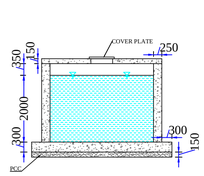

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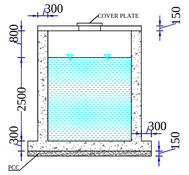

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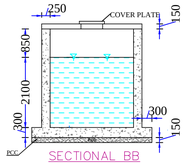

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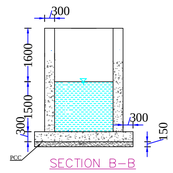
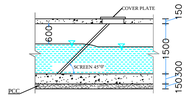
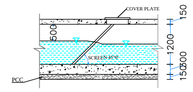


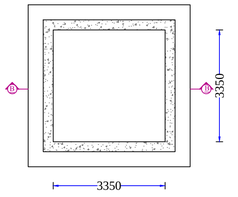
SECTION B–B



SECTIONAL ELEVATION

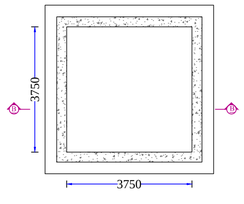


SECTIONAL ELEVATION



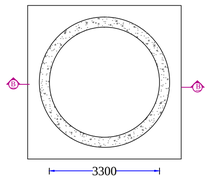
MOVING BED BIO–FILM REACTOR–MBBR TANK 4

(BOD REMOVAL AFTER DE–NITRIFICATION)



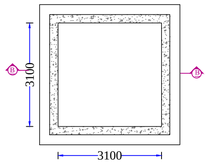
PLAN

CHLORINE CONTACT TANK



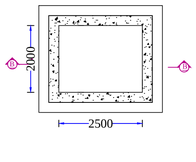
PLAN

SLUDGE THICKENER



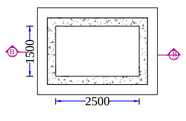
PLAN

FILTER FEED TANK



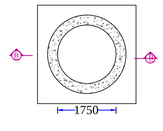
PLAN

GRIT SEPERATOR



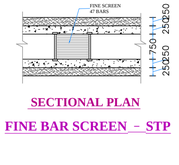
PLAN

RECEIVING CHAMBER -STP



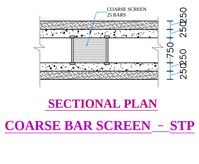
PLAN

SLUDGE SUMP



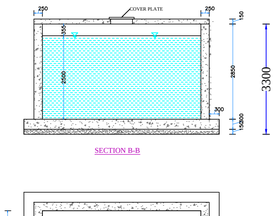
SECTIONAL PLAN

FINE BAR SCREEN – STP

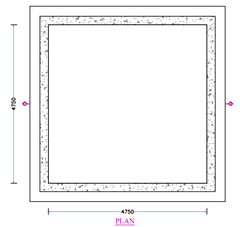


SECTIONAL PLAN

COARSE BAR SCREEN – STP

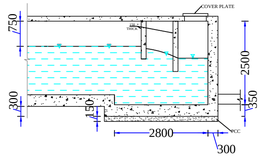


SECTION B-B

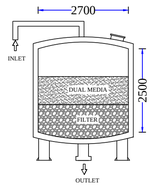


PLAN

TREATED WATER TANK

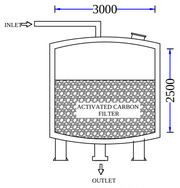


OIL & GREASE TRAP – STP



SECTION

PRESSURE SAND FILTER



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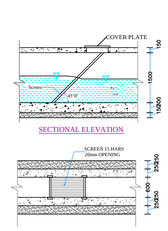
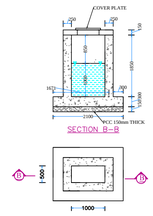
ACTIVATED CARBON FILTER



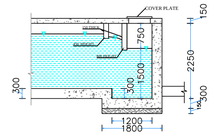
SECTIONAL PLAN

COARSE BAR SCREEN – CTU

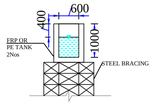


SECTIONAL PLAN

RECEIVING CHAMBER – CTU

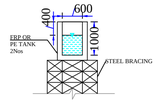


OIL & GREASE TRAP – CTU



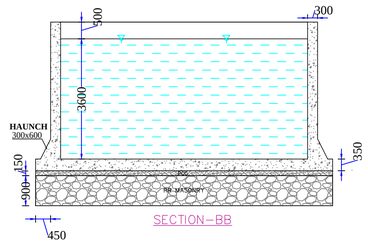
SECTION

ALUM SOLUTION TANK

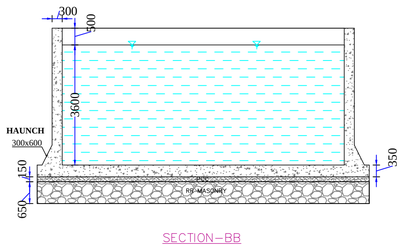


SECTION

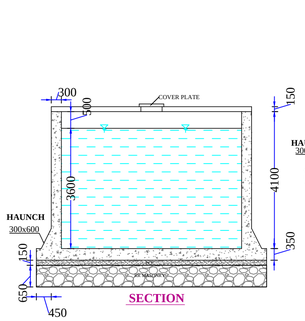
LIME SOLUTION TANK



SECTION–BB



SECTION–BB



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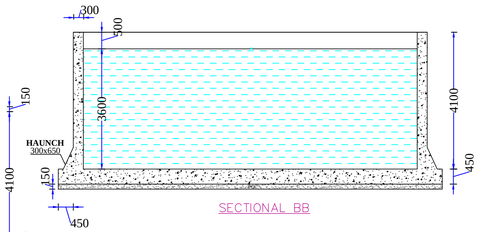
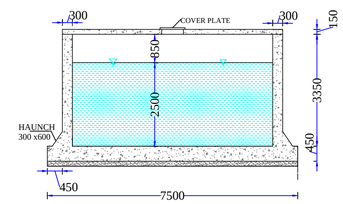
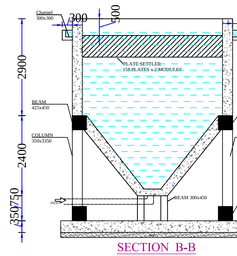


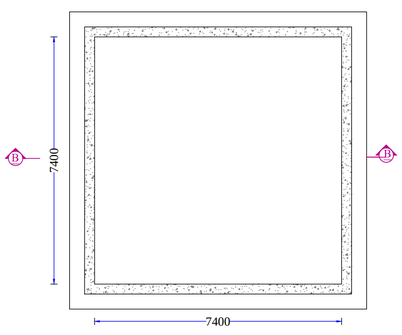
SECTIONAL BB



SECTION B–B

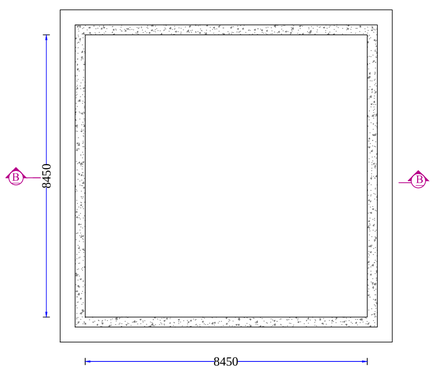


SECTION B-B



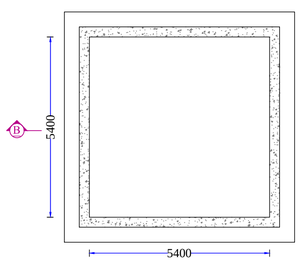
SECTIONAL PLAN

MOVING BED BIO-FILM REACTOR-MBBR TANK 1 (BOD REMOVAL)



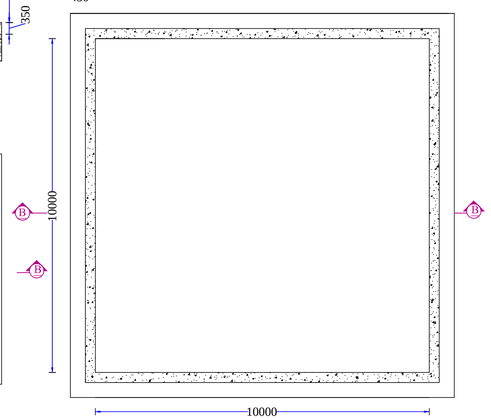
SECTIONAL PLAN

MOVING BED BIO-FILM REACTOR-MBBR TANK 2 (NITRIFICATION)



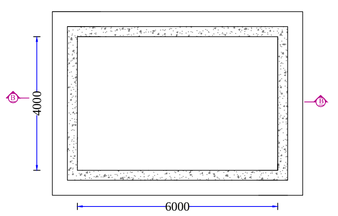
SECTIONAL PLAN

MOVING BED BIO-FILM REACTOR - MBBR TANK 3 (DE-NITRIFICATION)



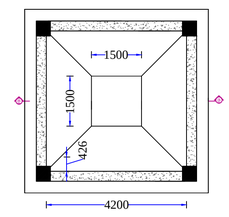
SECTIONAL PLAN

EQUALIZATION TANK



SECTIONAL PLAN

DILUTION TANK – CTU



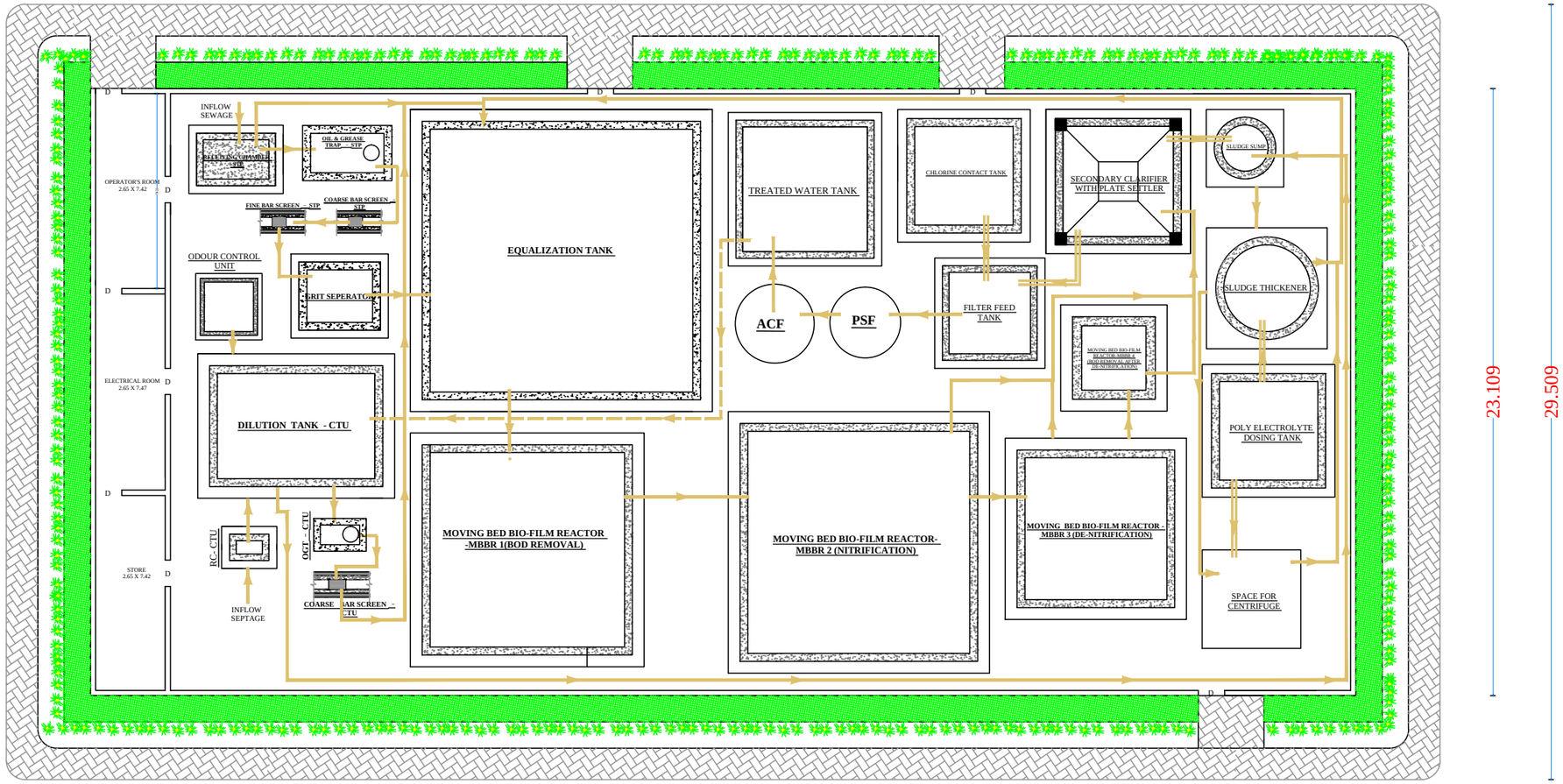
PLAN

SECONDARY CLARIFIER WITH PLATE SETTLER

KERALA WATER AUTHORITY		PREPARED BY: SEWERAGE CIRCLE THRISSUR
SEWERAGE CIRCLE THRISSUR		AE. GIRANCHANDRAN A C
		AEE. PRIYADARSHINI B
		EE . SHYJU P THADATHIL
		SE . JAMAL P
		ALL DIMENSIONS ARE IN mm.
SCALE :	1.35 MLD CAPACITY SEWERAGE SYSTEM FOR WADAKKANCHERY MUNICIPALITY	FILE NO : PPD/TSR/SEW-3/2021
DATE: 28-12-2021	TITLE : COMPONENTS DRAWINGS - STRUCTURAL	DRAWING NO :

Annexure IV

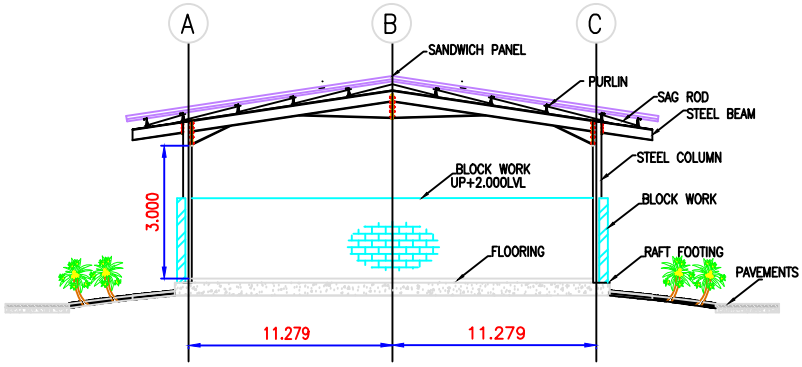
LAYOUT OF PROPOSED SEWAGE TREATMENT PLANT



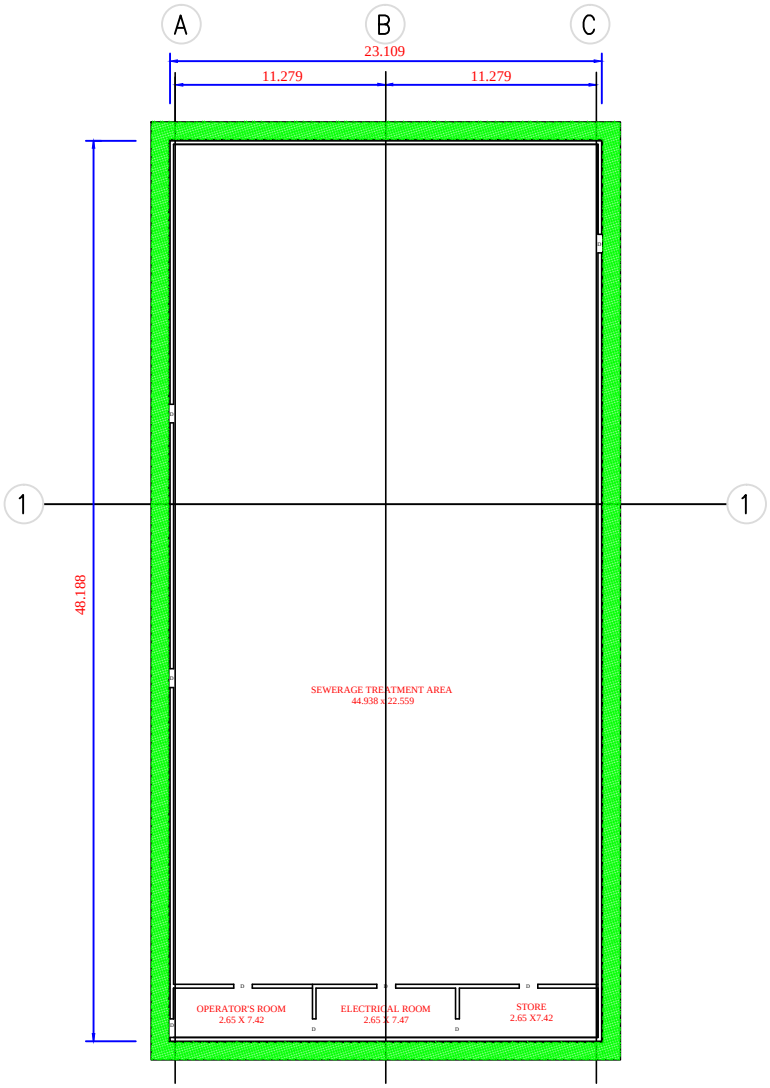
KERALA WATER AUTHORITY SEWERAGE CIRCLE THRISSUR		**PREPARED BY: SEWERAGE CIRCLE THRISSUR** AE. GIRANCHANDRAN A C AEE. PRIYADARSHINI B EE . SHYJU P THADATHIL SE . JAMAL P ALL DIMENSIONS ARE IN m
SCALE : DATE: 28-12-2021	**1.35 MLD CAPACITY SEWERAGE SYSTEM FOR WADAKKANCHERY MUNICIPALITY** TITLE: LAYOUT OF PROPOSED SEWAGE TREATMENT PLANT	FILE NO : PPD/TSR/SEW-3/2021 DRAWING NO :

Annexure V

TRUSS WORK FOR SEWAGE TREATMENT PLANT



SECTIONAL ELEVATION

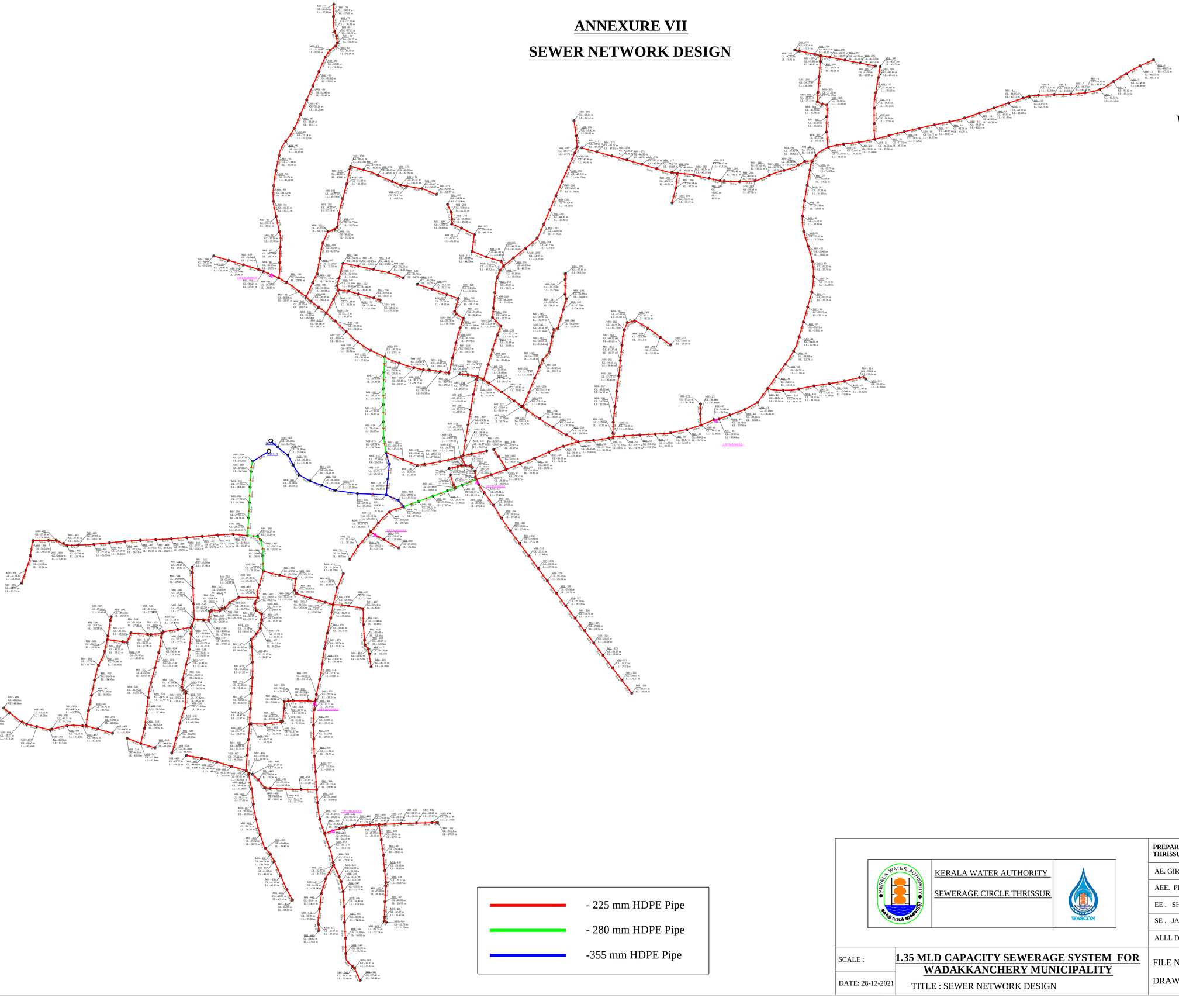


PLAN

KERALA WATER AUTHORITY SEWERAGE CIRCLE THRISSUR		PREPARED BY: SEWERAGE CIRCLE THRISSUR AE. GIRANCHANDRAN A C AEE. PRIYADARSHINI B EE . SHYJU P THADATHIL SE . JAMAL P ALL DIMENSIONS ARE IN m
SCALE : DATE:28-12-2021	1.35 MLD CAPACITY SEWERAGE SYSTEM FOR WADAKKANCHERY MUNICIPALITY TITLE: TRUSS WORK FOR SEWERAGE TRETMENT PLANT	FILE NO : PPD/TSR/SEW-3/2021 DRAWING NO :

ANNEXURE VII

SEWER NETWORK DESIGN



KERALA WATER AUTHORITY

SEWERAGE CIRCLE THRISSUR

WASCON

PREPARED BY: SEWERAGE CIRCLE THRISSUR

AE. GIRANCHANDRAN A C	
AEE. PRIYADARSHINI B	
EE . SHYJU P THADATHIL	
SE . JAMAL P	
ALLL DIMENSIONS ARE IN m.	

SCALE :

DATE: 28-12-2021

1.35 MLD CAPACITY SEWERAGE SYSTEM FOR WADAKKANCHERY MUNICIPALITY

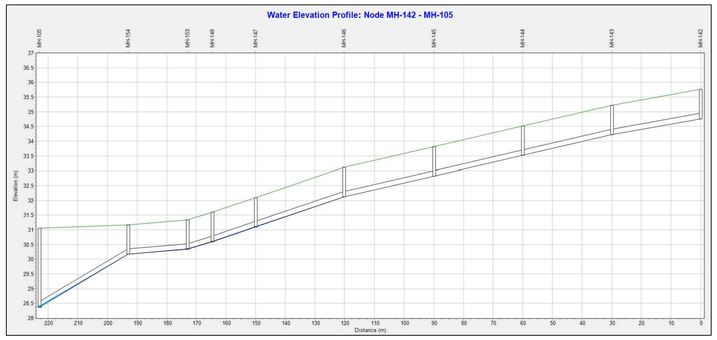
TITLE : SEWER NETWORK DESIGN

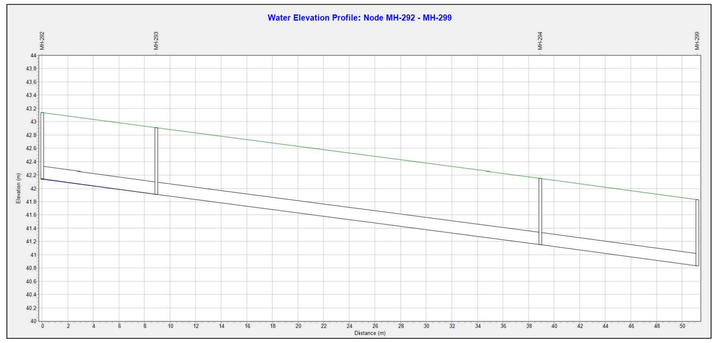
FILE NO : PPD/TSR/SEW-3/2021

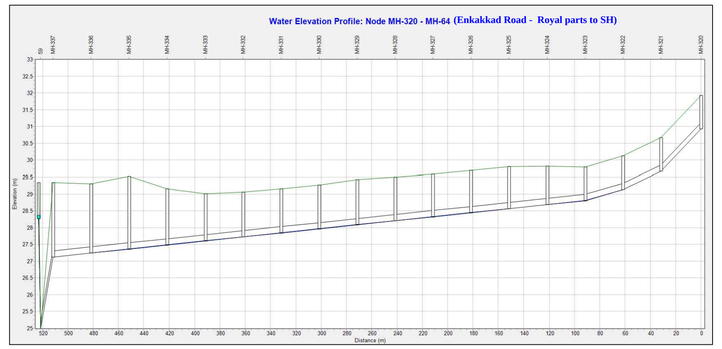
DRAWING NO :

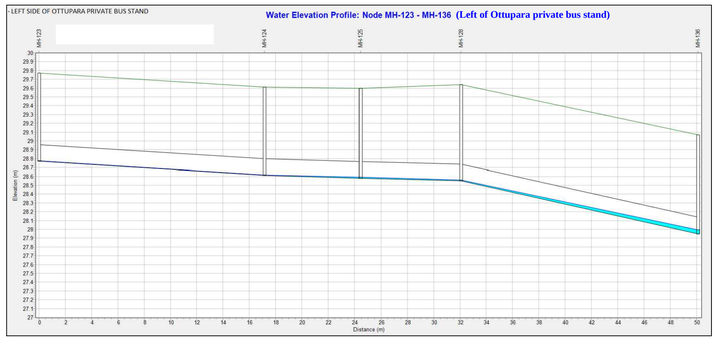
ANNEXURE VIII(A)

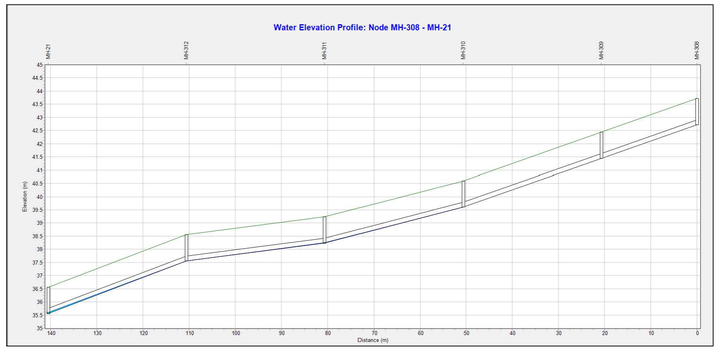
PROFILE PLOT

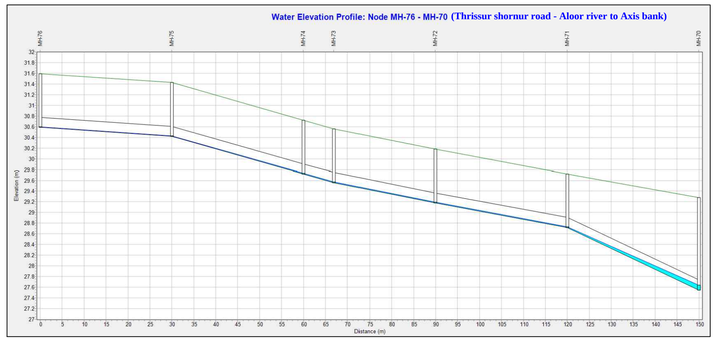


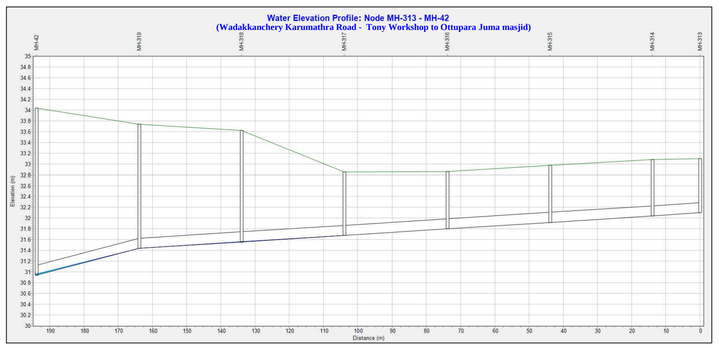


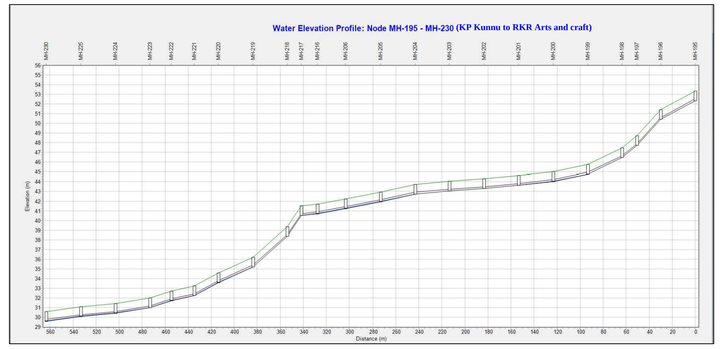


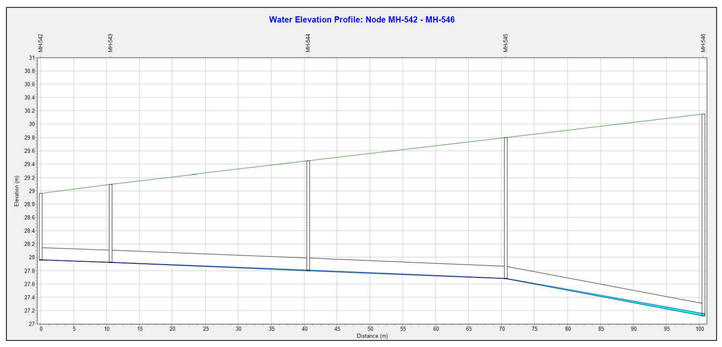


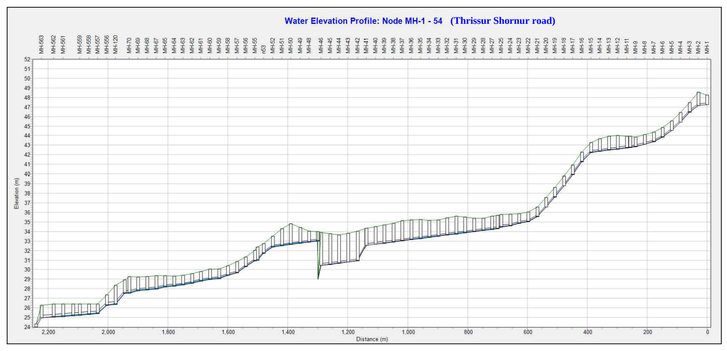


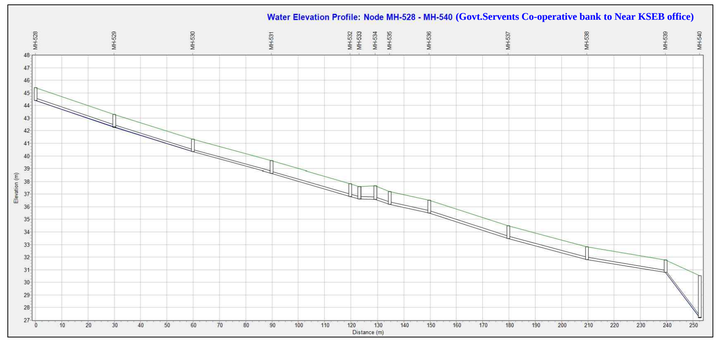








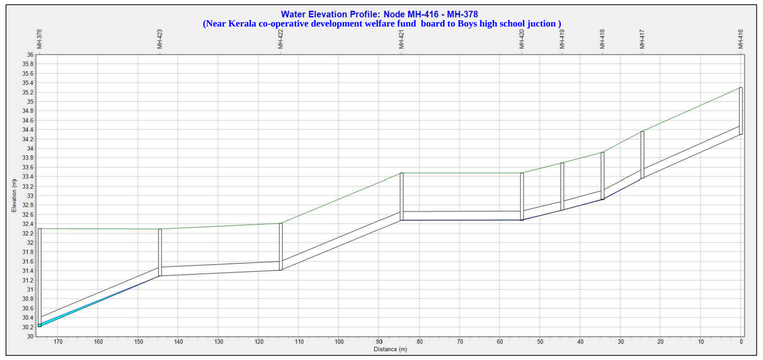


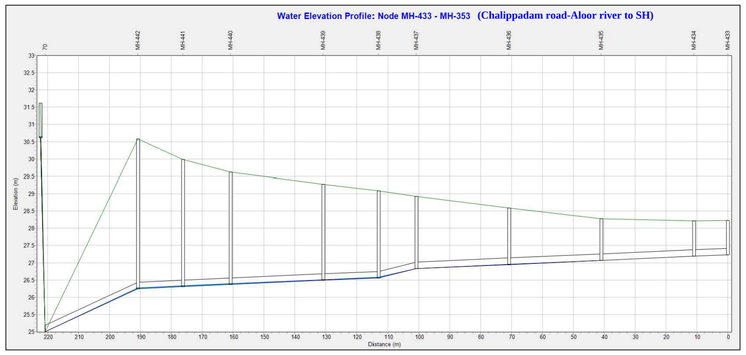


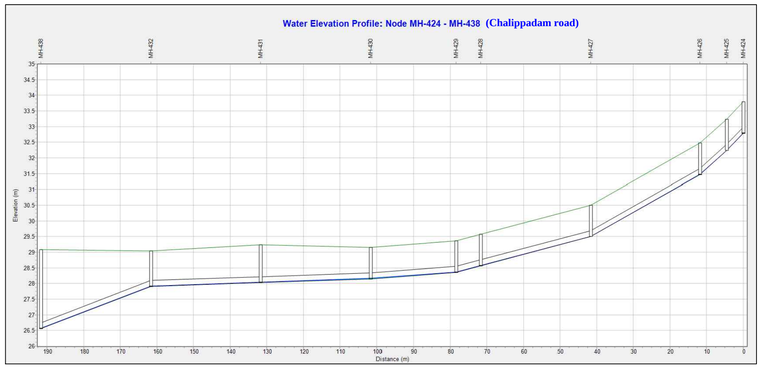
KERALA WATER AUTHORITY			PREPARED BY: SEWERAGE CIRCLE THRISSUR
SEWERAGE CIRCLE THRISSUR			AE. GIRANCHANDRAN A C
			AEE. PRIYADARSHINI B
			EE. SHYJU P THADATHIL
			SE . JAMAL P
SCALE :	1.35 MLD CAPACITY SEWERAGE SYSTEM FOR WADAKKANCHERY MUNICIPALITY		FILE NO : PPD/TSR/SEW-3/2021
DATE: 28-12-2021	TITLE : PROFILE PLOT		DRAWING NO :

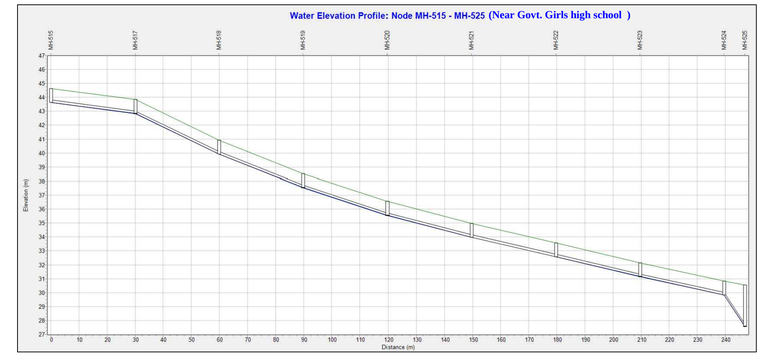
ANNEXURE VIII(B)

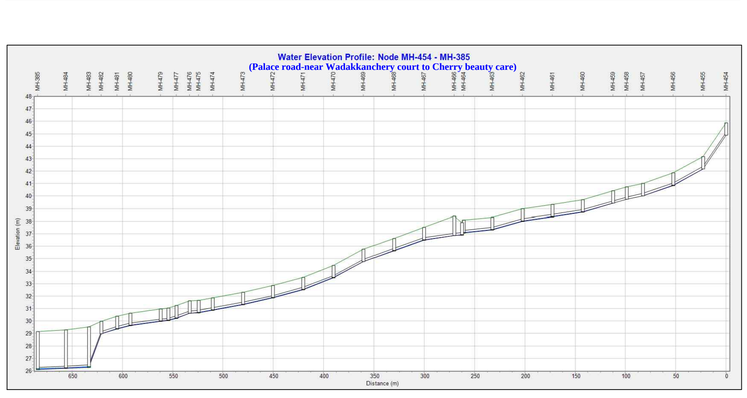
PROFILE PLOT

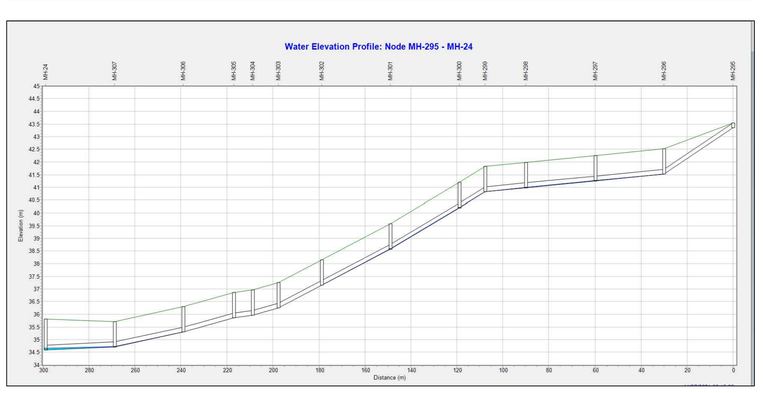


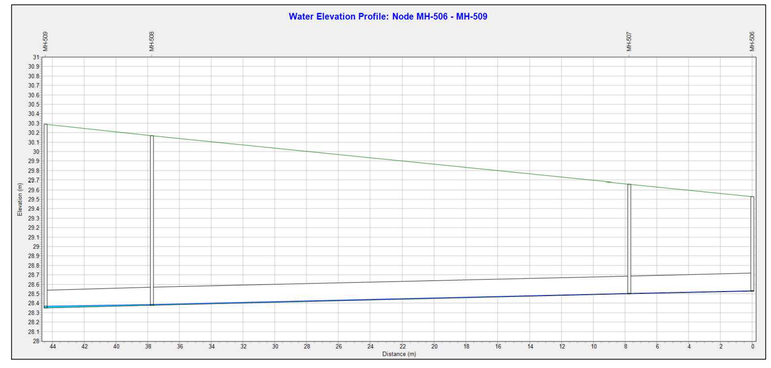


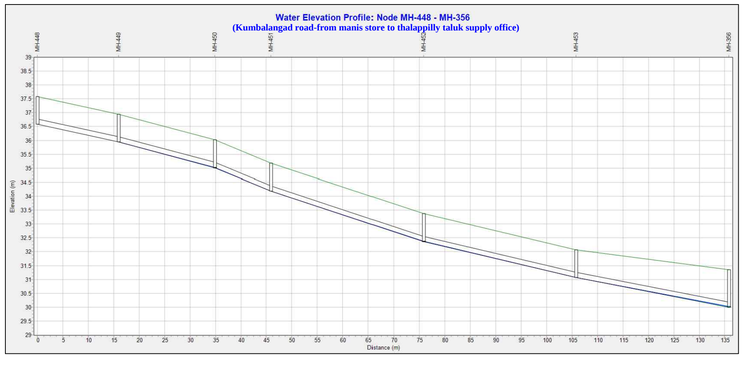


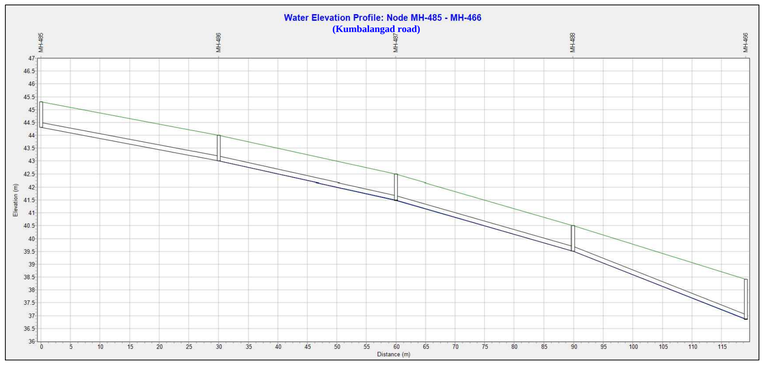








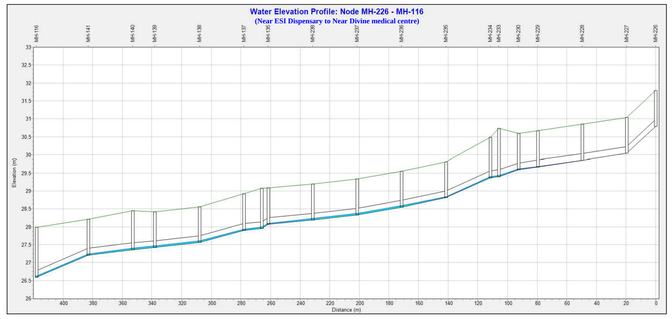


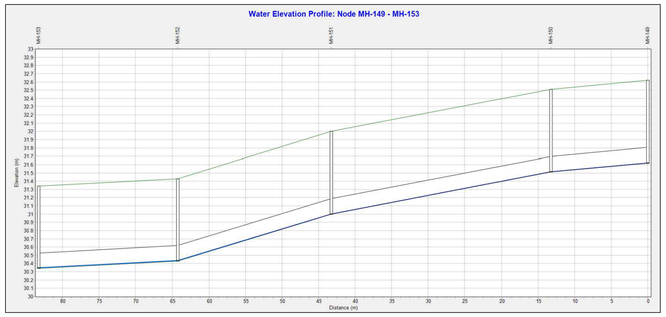


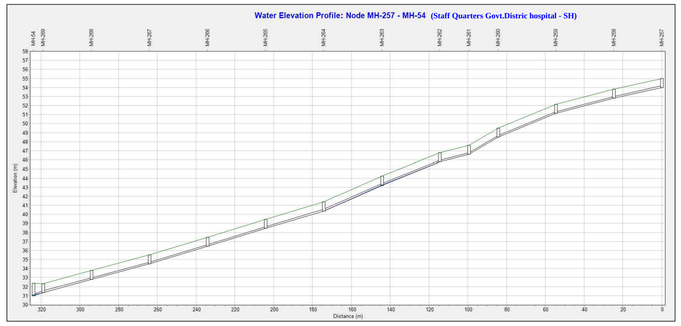
KERALA WATER AUTHORITY		PREPARED BY: SEWERAGE CIRCLE THRISSUR
SEWERAGE CIRCLE THRISSUR		AE. GIRANCHANDRAN A C
		AEE. PRIYADARSHINI B
		EE . SHYJU P THADATHIL
		SE . JAMAL P
SCALE :	1.35 MLD CAPACITY SEWERAGE SYSTEM FOR WADAKKANCHERY MUNICIPALITY	FILE NO : PPD/TSR/SEW-3/2021
DATE: 28-12-2021	TITLE : PROFILE PLOT	DRAWING NO :

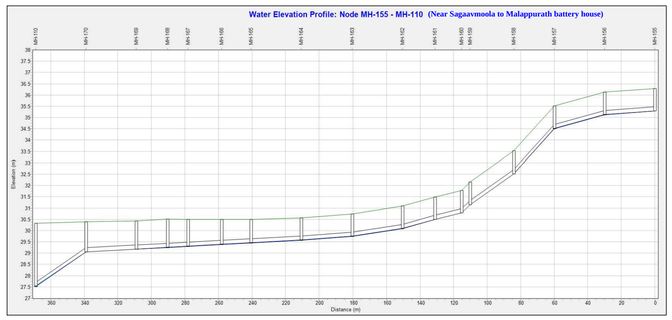
ANNEXURE VIII(C)

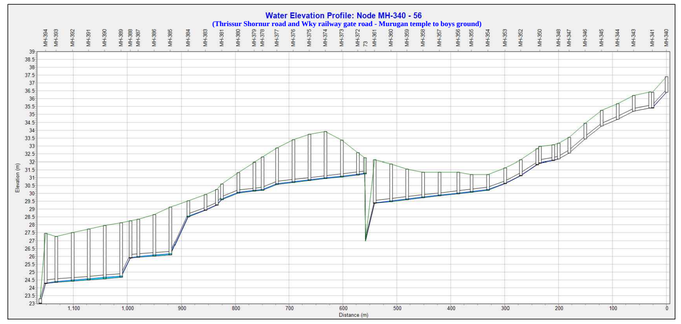
PROFILE PLOT

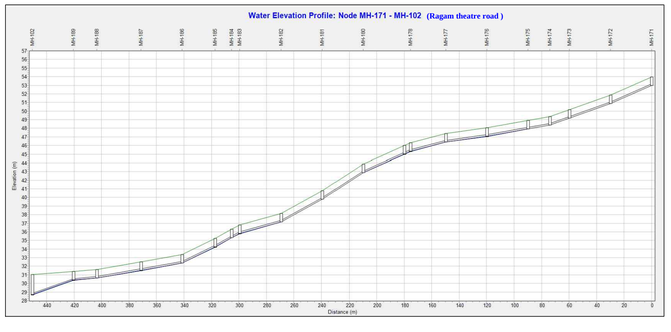


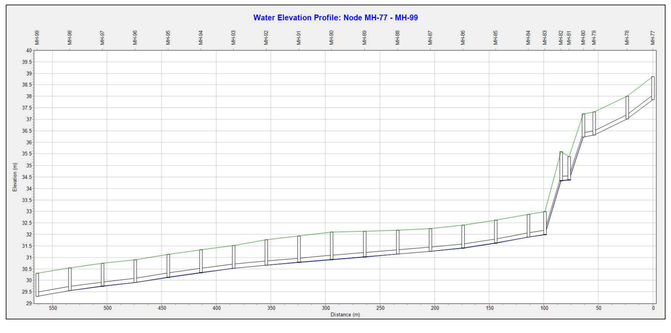


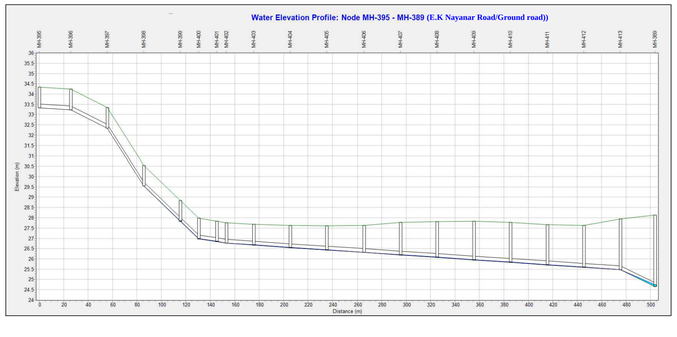












KERALA WATER AUTHORITY

SEWERAGE CIRCLE THRISSUR

PREPARED BY: SEWERAGE CIRCLE THRISSUR

AE. GIRANCHANDRAN A C	
AEE. PRIYADARSHINI B	
EE . SHYJU P THADATHIL	
SE . JAMAL P	

SCALE :

DATE: 28-12-2021

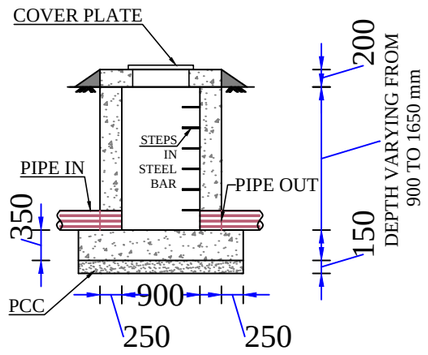
1.35 MLD CAPACITY SEWERAGE SYSTEM FOR WADAKKANCHERY MUNICIPALITY

TITLE : PROFILE PLOT

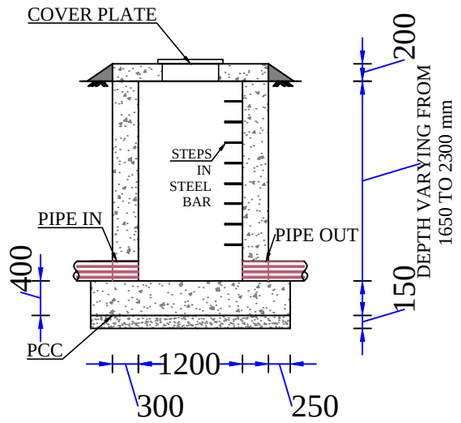
FILE NO : PPD/TSR/SEW-3/2021

DRAWING NO :

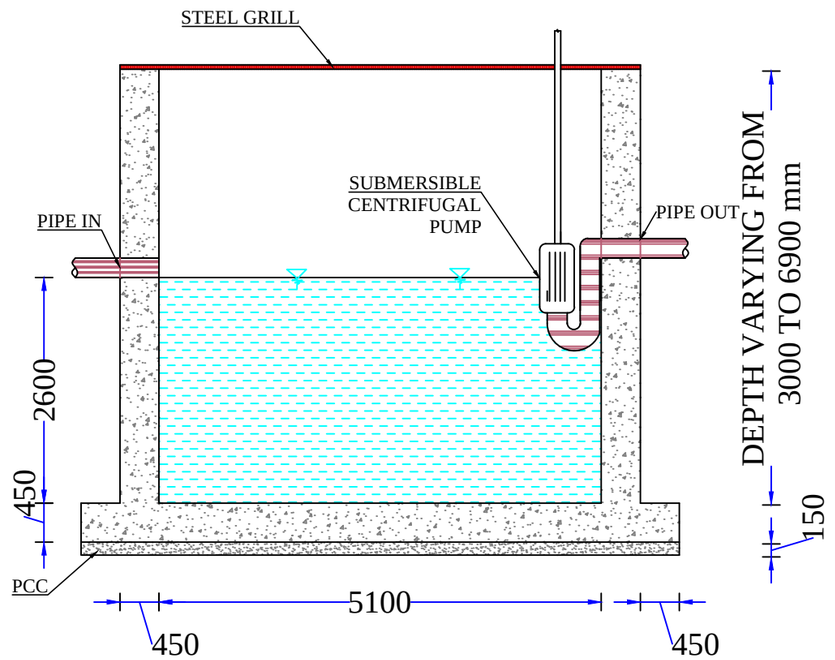
ANNEXURE IX - TYPICAL MANHOLES, LIFT MANHOLE &WELL



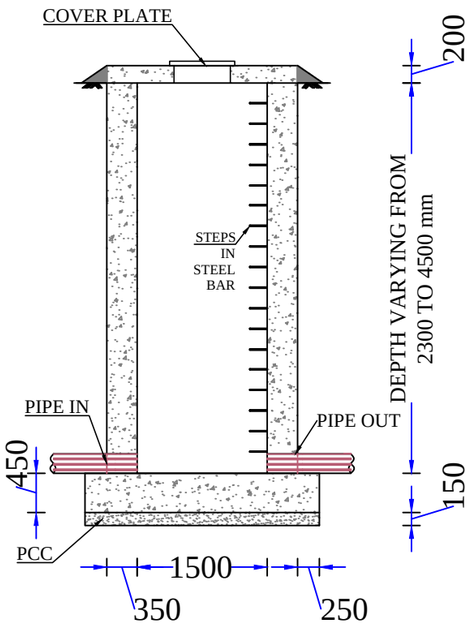
CLASS -I



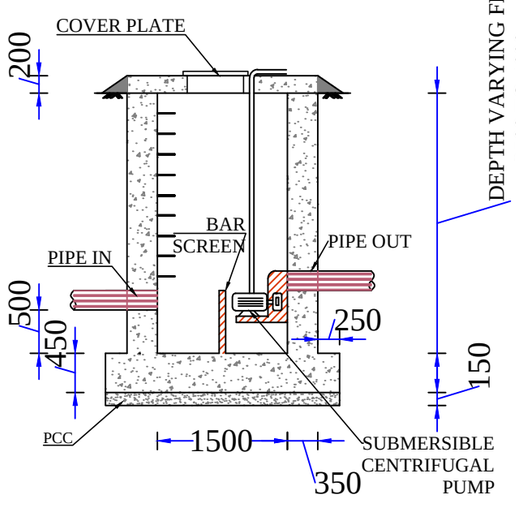
CLASS - II



COLLECTION WELL



CLASS - III



LIFT MANHOLE

KERALA WATER AUTHORITY

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EE . SHYJU P THADATHIL	
SE . JAMAL P	

ALL DIMENSIONS ARE IN mm.

SCALE :

DATE:

1.35 MLD CAPACITY SEWERAGE SYSTEM FOR WADAKKANCHERY MUNICIPALITY

TITLE :MAN HOLE,LIFT MANHOLE AND COLLECTION WELL

FILE NO : PPD/TSR/SEW-3/2021

DRAWING NO :