

BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL,
SOUTHERN ZONE, CHENNAI

Appeal No. 03 of 2021 (SZ)

With

Appeal No.04 of 2021 (SZ)

Lingam Nagar Welfare Association,
Rep. by V. Thirugnanasambandam S/o. A. Vishwanathan,
Lingam Nagar Residents,
Kuzhumani Road, Trichy.

...Appellant(s)

Versus

The Chairman,
Tamil Nadu Pollution Control Board,
Guindy, Chennai
& Ors.

...Respondent(s)

Faecal Sludge Treatment Project -
Process Description
filed on behalf of the Respondent Nos. 3 and 4.

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FSTP – PROCESS DESCRIPTION

TIRUCHIRAPPALLI

CDD SOCIETY

9/30/2016

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Introduction

Tiruchirappalli is a City Corporation in the state of Tamil Nadu with an area of 167 Sq.Km. The core area of the city has a centralized sewerage network with a Waste stabilization pond (WSP) for treatment. However there are a few pockets and areas within the corporation limits that are not connected to networked sewerage and rely on on-site sanitation systems for containing the black water. The onsite sanitation infrastructure at the household and community (shared, community and public) levels are mostly septic tanks and pits. These get filled over an interval of 2-3 years, post which they require to be desludged. Desludging is carried out using vacuum pumps owned by private operators or City Corporation. The sludge is currently being disposed at designated areas from where it travels through sewerage networks to WSP. At times these desludging vehicles dispose in vacant or farm lands due to difficulty in access to the disposal sites. A designated treatment plant hence becomes necessary for safe handling and disposal of faecal sludge.

Tamil Nadu urban support program is funded by the Bill and Melinda Gates Foundation (BMGF) and aims to create an enabling environment for scaling up faecal sludge management solutions across the state of Tamil Nadu. It is for this purpose that a pilot faecal sludge treatment plant is being set up in the corporation limits of Tiruchirappalli. The faecal sludge treatment plant (FSTP) of capacity 32 Kilo litres per day is designed to treat sludge generated from pits, septic tanks, public toilet/community toilet containment units and wastewater sludge.

Criteria Adopted for Design of Faecal sludge Treatment System

The proposed location of the FSTP is on the Kulamani Road near Kasi-Vilangi on the north western part of the city. The land of 4.0 acres is owned by the TCC and is bifurcated into three parts. The northern part is the site proposed for FSTP, while the southern part is for a proposed fish market. Figure 1 shows the various divisions of the land, the centre portion is proposed for a buffer zone consisting of thick vegetation between the FSTP and fish market. The site is located at a distance of 6 kms from the centre of the city, the total area of the proposed site is 4 acres and it's owned by Trichy City Corporation. The site is well connected with the town with a four meter approach road. There will be no hurdles for the desludging vehicle of around 4000 liters to come to the proposed location and dispose the Septage to the Faecal sludge treatment plant if implemented.

Faecal Sludge mainly contains the liquid and solid material pumped from septic tank or pits during the cleaning of septic tanks/pits. It is normally characterized by large quantities of grit and grease, high solids and organics contents, poor settling, high wastewater strength due to accumulation of sludge and scum and an offensive odour.

In order to design the pilot faecal sludge treatment facility, the following design parameters have been adopted:

Source and Quantity of Faecal sludge

The source of faecal sludge is from the septic tanks, pits and other on-site containment units from part of Ward 40, 45, 52, 53, 54 and 60 which are not connected to sewerage system. Faecal sludge from household septic tanks/pits and other institutions is conveyed to the treatment facility using the desludging truck available with the TCC or private operators which has capacities ranging from 4000 to 6000 litres.

Under this project, it is proposed to treat maximum of eight loads of faecal sludge (assuming a truck load of 4 KL) from the desludging trucks which amounts to maximum of 32000 litres of sludge input every day into the treatment facility.

Faecal sludge Characteristics

Faecal Sludge characteristics vary widely from one location to another. This variation is due to several factors, which includes number of users of the septic tank at the household, kind of waste disposed in the septic tank, size of the tank and desludging frequency, climatic conditions and the construction specifications of the septic tank.

Knowledge of the faecal sludge characteristics and its variability is very important in designing the treatment facility. Based on the past experience, literature review and samples

collected from the pits/septic tanks in and around TCC, the faecal sludge characteristics considered for designing the facility is as follows

Table 1: General Characteristics of the faecal sludge

Sl.No	Parameters	Concentration
1	Biochemical Oxygen Demand (BOD), mg/l (average)	20000
2	Chemical Oxygen Demand (COD), mg/l (average)	40000
3	Total Solids (TS), mg/l (average)	45000
4	Settable Solids (SS), % (average)	25
5	pH	7.8
6	Ammonium as N, mg/L	280 - 320

Faecal Sludge feeding into the tank (peak flow)

It is of utmost important to clearly define the rate at which the faecal sludge will be fed into the treatment system. The faecal sludge feeding into the treatment system during the day depends on the time of faecal sludge collected and delivered from the desludging trucks. The treatment modules are designed considering a flow rate generated by discharging 4 Kilo litres of faecal sludge being discharged from the truck into the treatment plant in 8-10 minutes time.

Hydraulic Retention Time

In order to ensure the effective treatment of sludge as well as sludge water, it is necessary to provide adequate sludge and hydraulic retention time for each of the treatment module proposed. The proposed Solids and Hydraulic Retention Time for each of the treatment modules are explained in the subsequent headings.

Climatic Conditions

In order to ensure the effective treatment process, it is necessary to consider the climatic conditions for design of treatment modules, necessarily the temperature to ensure treatment efficiency, rainfall to ensure the drying of solids in the sludge drying beds. The design and detailing of the treatment modules are carried out taking the aforementioned factors into consideration.

Maximum temperature: 38⁰C(May)

Minimum temperature: 21.2⁰C (December)

Rainfall: maximum no. of days in a month: 8.5 (October), average precipitation - 186 mm

Treatment Concept

The treatment concept proposed for faecal sludge treatment in Tiruchirappalli has been developed considering mainly

- a) Maximum treatment efficiency
- b) Hygenisation and safe operation
- c) Minimum operation and maintenance requirements

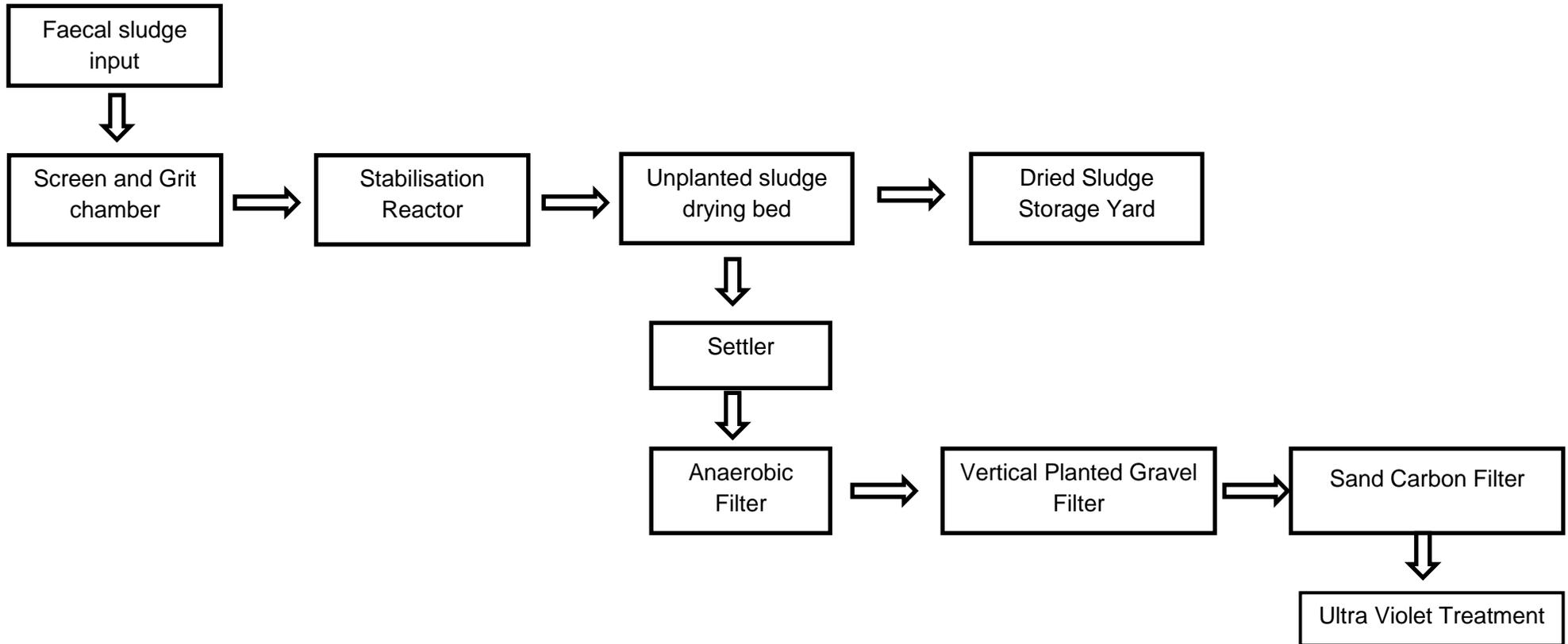
Treatment Stages and Modules adopted

The treatment modules proposed above are combined in a particular sequence for the complete treatment of the faecal sludge.

Table 2: Different Faecal sludge Treatment Stages and Modules

Sl. No	Treatment Stages	Treatment modules
1	Pre-Treatment	Screen and Grit chamber
2	Sludge stabilization	Stabilization Tank
3	Sludge drying	Sludge Drying Beds
4	Percolate treatment	Settler
		Anaerobic Filter
		Planted Gravel Filter
		Sand Carbon Filter
		Ultra violet treatment

Process Flow Diagram



Design Description of the Proposed Treatment Modules

The Treatment plant is subdivided into 4 decentralised units of 8 cum each within the FSTP site (see master plan). There are 4 Screen and grit chamber, 4 Stabilisation reactors and 48 sludge drying beds (12 for each stabilisation tank). However there is a common percolate treatment facility for 32 KLD; DEWATS- 1 Settler, 3 Anaerobic Filter, 2 Vertical Planted gravel filter and a final collection tank.

Screen and Grit chamber

It is a physical method of separation solid waste and inorganic solids like plastic, cloths, sand, slits etc. from faecal sludge to prevent the clogging subsequent treatment modules and also enhance the values of treatment end products. This is used to remove larger particles of floating and suspended matter by coarse screening. This is accomplished by a set of inclined parallel bars having opening.

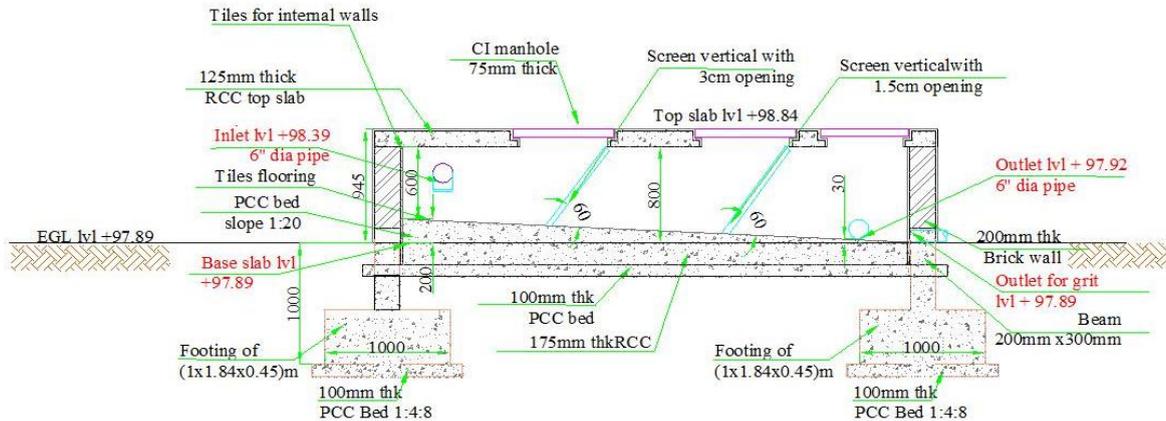


Figure 1: Section of Screening and Grit chamber

Grit chambers are like sedimentation tanks, designed to separate the intended heavier inorganic materials and to allow the lighter organic materials to pass through to the next treatment unit. Hence, the flow velocity is a decisive design consideration. The velocity should neither be too low as to cause the settling of lighter organic matter, nor should it be too high as to preclude the settlement of the silt and grit present in the sewage. A horizontal velocity of flow of 15 to 30 cm /sec is used at peak flows. The detention time proposed in the grit chamber varies between 30 to 60 seconds.

Table 3: Specifications for Screen and Grit chamber

Parameters	Unit	Values
Area required	m ²	12
Retention time	Seconds	30- 60
Number of screen and grit chambers		4 Nos

Stabilization Reactor

The main objective of the stabilization reactor is to allow the sludge to digest anaerobically which leads to reduced BOD and better dewaterability. During the anaerobic treatment process, there is also removal of degradable organic matter present in the faecal sludge. The stabilization process also helps in improving the sludge dewaterability and subsequent drying of solids.

The stabilisation reactor has 3 chambers. The first chamber has a retention time of 2 days and assists in homogenisation of sludge. The turbulence in the chamber is created by maintaining an up-flow velocity of 4-5 m/hr using the energy produced during discharge of sludge from the desludging vehicle into the module.

The second chamber has a retention time of 10 days and is designed to stabilise sludge through aiding the process of anaerobic digestion. The length of the chamber is kept low to prevent dead zones and liquid funnels that may be created at the outlet. A baffle wall is also designed for similar purpose. The up-flow velocity in this chamber is kept at 1.5 -2 m/hr, this is to disturb the sludge and help entrapped bio-gas to escape, thereby aiding liquid solid separation.

The third chamber retains the sludge for 1 day, this is used as an intermediate collection tank to empty the contents into the drying bed every day.

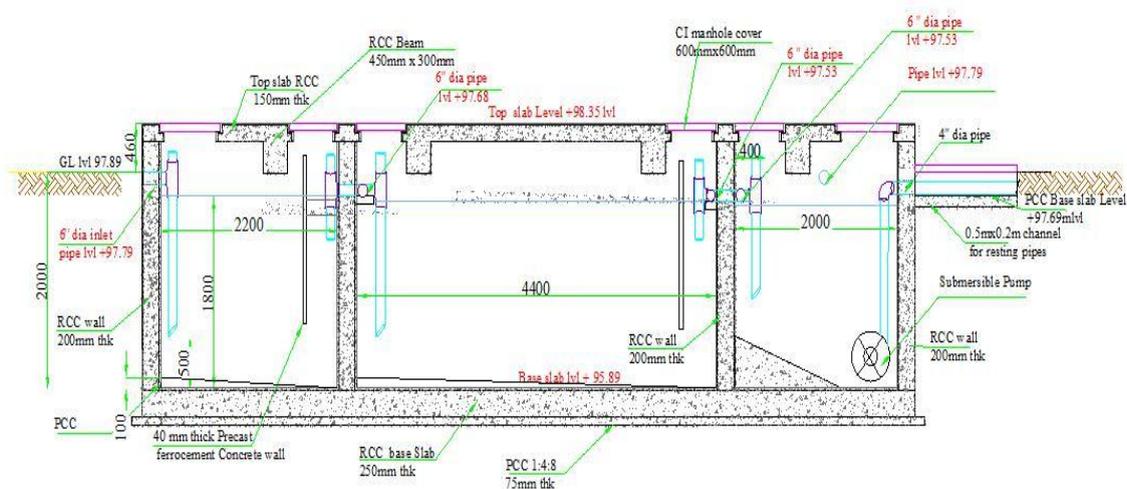


Figure 2: Section of Stabilization reactor

Table 4: Specifications for Stabilisation Reactor

Parameters	Unit	Values
No of chamber	No	3
Sludge treatment capacity per day per reactor	m ³	8
Total Volume of Tank	m ³	104
Retention time	Days	13
Slurry disposal into the drying bed	Day	Every day : 8 M ³
BOD outlet	mg /L	8000 – 10000
COD outlet	mg /L	15000 - 20000

Sludge Drying Bed

The liquid sludge retained at the bottom of the stabilization reactor is desludged and transferred to unplanted sludge drying beds. Sludge drying beds are open tanks filled with graded filter media. Each sludge drying bed can accommodate 8 m³ of digested faecal sludge. The drying time provided in the beds is 11 days.

The slurry from the stabilization reactor is fed into the sludge drying beds every day. The Maximum feed depth into each of the sludge drying bed is 25 centimetres considering that solids content in faecal sludge vary between 3 - 5%. The remaining quantity which is known as percolate would be conveyed from the bottom of the bed into the Integrated Settler and Anaerobic Filter for further treatment before being further treated. The sludge drying bed consists of different filter media placed at different depths.

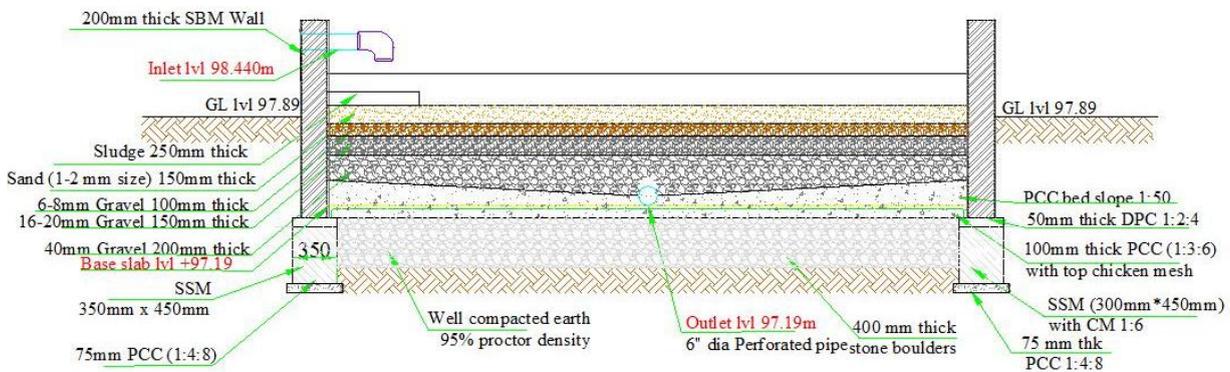


Figure 3 Section of sludge drying bed

Table 5: Specifications of Sludge Drying Bed

Parameters	Unit	Values
Total number of beds	-	48
Treatment volume of each bed	m ³	8
Estimated volume of Solid retained	%	30
Area required	m ²	39m ² per bed
Slurry feeding frequency	days	12 days
Slurry drying period	days	11
BOD outlet (percolate)	mg /L	300
COD outlet (percolate)	mg /L	800

Integrated settler and Anaerobic Filter

The percolate from the Sludge Drying Bed is further subjected to treatment in settler and Anaerobic Filter (AF). The incoming faecal sludge load has pretty high solids content. Therefore, it is proposed to provide a settler for sedimentation before it enters into the anaerobic filter.

The anaerobic filter is provided with 3 numbers of anaerobic fixed bed filter chambers. As the wastewater flows through the filter, particles are trapped and organic matter degraded by the biomass that is attached to the filter material.

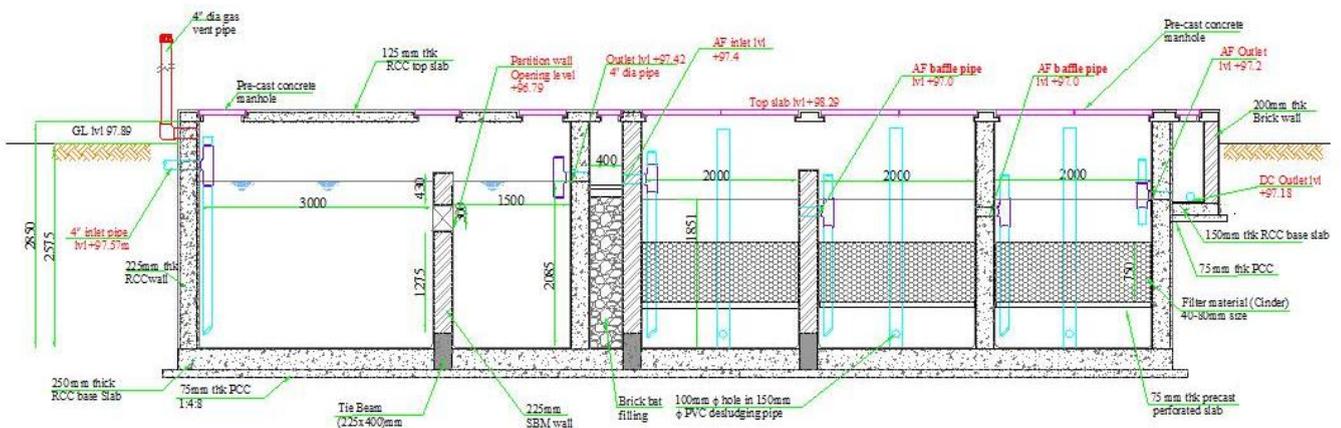


Figure 4 Integrated Settler and Anaerobic filter

Table 6: Specifications of Anaerobic filter (AF)

Parameters	Unit	Values
Faecal sludge quantity	m ³	32
Total number of chambers	-	2+3
Hydraulic Retention Time	hrs	36
Area required	m ²	60
BOD outlet	mg /L	<30
COD outlet	mg/L	200

Planted Gravel filter (PGF)

Organic load entering into the PGF is already within the required effluent BOD <30mg/L) requirement. In order to remove the odour and colour and to enrich the wastewater with oxygen it is necessary to allow the wastewater to pass through aerobic treatment. PGF is made of planted filter materials consisting of graded gravel. The bottom slope is 1% and the flow direction is vertical. The main plants used in this filter bed are *Canna indica*, Reed juncus, Papyrus and Phragmites. The plant selection is mainly based on their ability to grow in wastewater and have their roots spread wide. The vertical planted drying beds also aid in reducing the nutrients such as N, P and K present in wastewater.

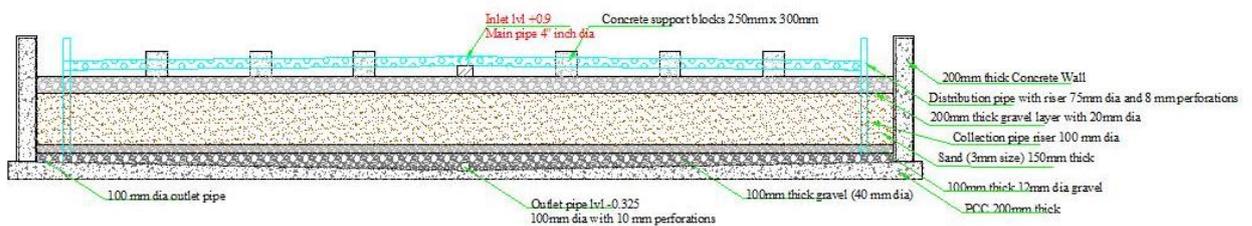


Figure 5 Section of Planted gravel filter

Table 7: Specifications of Planted Gravel Filter (PGF)

Parameters	Unit	Values
Percolate treatment quantity	m ³	32
Total number of PGF	-	2
Hydraulic Retention Time per PGF	min	1 hour
Area required per PGF	m ²	113
BOD outlet	mg /L	<20
COD outlet	mg /L	<50

TERTIARY TREATMENT

A tertiary treatment module like sand carbon filter and UV treatment is planned for post treatment of water coming out from the planted gravel filter and then disposed into the Kudamurutti channel/ river.

LAB FACILITY

An in-situ laboratory will be built with appropriate testing facilities for analysing faecal sludge and wastewater characteristics. The proposed laboratory will be equipped with the state-of-art sampling and analysis instruments. The in-situ laboratory is planned for continuous monitoring of FSTP performance and to ensure QA/QC of the outputs.

SAND AND CARBON FILTER

Carbon filtering uses a bed of activated carbon to remove chlorine, sediment, volatile organic compounds (VOCs), taste and odor using chemical adsorption and with that sand filters for effluent treatment are used to filter wastewater by promoting the development of a biological activity that breaks down organic matter.

Technical Specification:

1. Sand Filter:

Vessel MS	: 1 No.
Vessel Dia & height:	800 mm & 1200mm
Type of Vessel	: Vertical
Flow Rate	: 6 M ³ /hr
Design Pressure	: 5 kg/cm ²
Maximum Pressure	: 3.5 kg/cm ²
Operating Pressure	: 3.5kg
Minimum Pressure	: 1 kg
Frontal Pipe work	: lumpsum
Multiport valve	: 40 NB

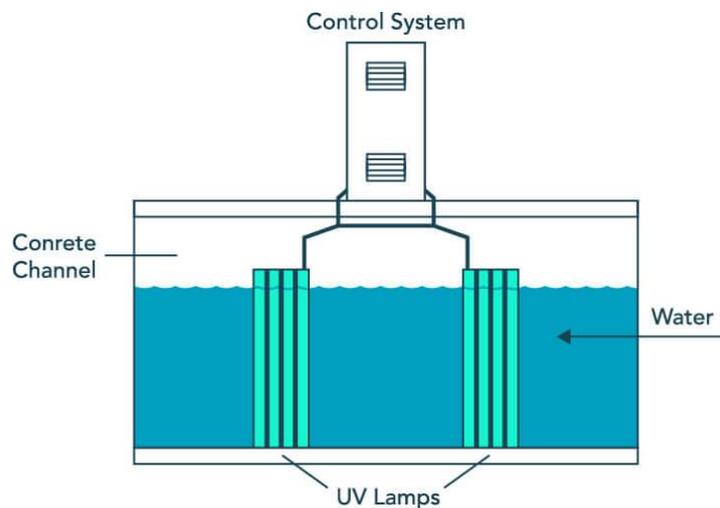
2. Activated Carbon Filter:

Vessel MS	: 1 No.
Vessel dia & height	: 800mm&1200mm
Type of Vessel	: Vertical
Flow Rate	: 7 M ³ /hr

Design Pressure : 5 kg/cm²
Maximum Pressure : 3.5 kg/cm²
Operating Pressure : 3.5kg
Minimum Pressure : 1 kg
Frontal Pipe work : lumpsum
Multiport valve : 40 NB

UV DISINFECTION

UV disinfection is a physical process that instantaneously neutralizes microorganisms as they pass by ultraviolet lamps submerged in the effluent. This process adds up nothing to the water but UV light, and therefore, has no impact on the chemical composition or the dissolved oxygen content of the water.



End product Specifications

The treatment system has two end products namely:

- a) Bio solids
- b) Treated Water

The specifications of the end products are listed below

Bio Solids

Bio solids are dried sludge from drying beds and which are stored for a period of 4-6 months for further stabilisation and reducing of pathogens. Sludge removed from drying beds are stored as heaps in sludge storage yards, during which helminth eggs and other pathogens get deactivated or their effectiveness reduces. Bio solids can be used as a soil conditioner for farming as they are a rich source of Nitrogen, carbon and phosphorous.

Table 8: Bio-solids characteristics

Parameters	Characteristics
P ^H at 5 % suspension	5- 7
Moisture %	10 - 30 %
Organic carbon %	10 – 25 %
Organic Nitrogen	2- 5 %
Phosphorous	0.2 – 1%
Bulk Density (Specific gravity)	0.65 – 0.9

Treated Water

Water from liquid treatment modules are stored in a collection tank from where it can be reused for irrigating plantations in nearby farm lands and buffer zones next to the proposed FSTP. The characteristics of the treated water are as follows:

Table 9: Treated water characteristics

Parameters	Characteristics of treated water
P ^H	6.5-9
Temperature	25 -35 ⁰ C
BOD at 5 days mg/L	Less than 10
COD mg/L	Less than 50
Total suspended solids mg/L	Less than 20
Faecal coliform per 100 mL	Less than 100
Total Nitrogen mg/L	Less than 10

