2017

Detailed Project Report for Faecal Sludge Management Solutions for Bhagalpur City, Bihar

Sanitation Capcity Building Platform

CDD Society

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Faecal Sludge Management Solutions for Bhagalpur (Bihar) under the Sanitation Capacity Building Platform- Version 1

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Abbreviations

SCBP	: Sanitation and Capacity Building Platform
NIUA	: National Institute of Urban Affairs
DEWATS	: Decentralised wastewater Treatment System
PDB	: Planted Drying Bed
SDB	: Sludge Drying Bed
VPGF	: Vertical Planted Gravel Filter
HH	: Households
ODF	: Open defecation free
OBA	: Output Based Assistance
EO	: Executive Officer
INR	: Indian Rupees
FSM	: Faecal Sludge management
O&M	: Operation and Maintenance
IEC	: Informational & Educational Campaigns
CBO	: Community Based Organizations
MoUD	: Ministry of Urban Development

Glossary

Sewage or Blackwater

The wastewater generated from toilets that is a mixture of human excreta, urine, anal cleansing and flushing water.

Sullage or Greywater

The wastewater from bathroom, kitchen, washing areas and other anthropogenic activities other than wastewater coming from toilet.

Faecal sludge

The sludge (semi solid matter) removed periodically from a scientifically constructed septic tank connected to toilets.

Faecal Sludge

Faecal sludge (FS) comes from onsite sanitation technologies, and has not been transported through a sewer. It is raw or partially digested, a slurry or semisolid, and results from the collection, storage or treatment of combinations of excreta and blackwater, with or without greywater. Examples of onsite technologies include pit latrines, unsewered public ablution blocks, septic tanks, aqua privies, and dry toilets. FSM includes the storage, collection, transport, treatment and safe enduse or disposal of FS. FS is highly variable in consistency, quantity, and concentration.

Pour flush toilets

Toilets were the flush water is manually poured into the pan

Cistern flush toilet

Toilets were water is flushed for pan cleansing thought means of a cistern or a tank.

1. Introduction

The waste generation in India has increased sharply owing to rapid population growth and urbanization over the past couple of decades. According to a study conducted by World Bank in 2006, it was estimated that approximately 50% of the Indian population lives in unhygienic conditions. Among the 350 million urban residents in India, 206 million (58.8 %) urban households do not have access to a drainage network, of which 102 million (29 % of the urban population) are connected to septic tanks, and 60 million (17%) use pit or vault latrines. Though the number of people in India practicing open defecation has marginally reduced, the management of onsite sanitation facilities such as septic tanks and pits remain a neglected component of provision of safe sanitation facilities. With around 102 million septic tanks and 60 million pits in the country (World Bank, 2006), India is yet to establish FSM as a main stream sanitation approach.

Faecal sludge is a fluid mixture of untreated and partially treated sewage solids, liquids and sludge of human or domestic origin. In other words, faecal sludge is sludge from onsite sanitation systems that is a combination of raw primary sludge and anaerobically digested sludge. Generally, faecal sludge has three main components as follows:

Scum – floats on top and is generally where the bacteria that live treat the waste

Effluent – the semi – treated liquid that comprises the majority of the material in the septic tank

Sludge – solids which collect at the bottom of the tank

The physio – chemical characteristics of the faecal sludge can vary depending on the characteristics namely the size and type of onsite sanitation system, design, desludging interval and the local climatic conditions of the place where the tank is located, the quantity and quality of water supplied and the type of wastewater originating from the household (which is user specific).

Faecal Sludge when not managed properly can cause pollution of waterways including groundwater. Such situations have serious implications on health and environment. It is projected that by 2015, the proportion of urban Indian population with access to improved sanitation facilities will increase to 80% (from 43% in 1990) and for rural population, the projection is 48% (from 1% in 1990). As per projections made by United States Agency for International Development in 2010, by 2017 it is expected that 148 million urban population in the country would have septic tanks and about 425 million rural population would have gained access to improved sanitation facilities. Thus, it is clear that the number of onsite sanitation systems will only grow over the next few years.

Though faecal sludge management poses a national problem, it can also be viewed as a potential resource. When properly managed, faecal sludge can be a useful resource than a waste. Faecal Sludge contains plant nutrients such as nitrogen, phosphorous which is contributed by human urine and faeces. Faecal sludge can reduce reliance on chemical fertilizers, and when combined in adequate amounts with fertilizers can provide the requisite nutrients for crop production.

Majority of onsite sanitation systems such as septic tanks and pits require frequent desludging which should be in accordance with the design and capacity of the system. Desludging however takes place only when there is odour and overflow of the contents from the tanks, which is much after the treatment efficiency of such systems have fallen. The overflow of the tank then finds its way into the nearest waterways and pollutes it. Faecal sludge, which is rich in nutrients such as nitrogen and phosphorous, disposed untreated into surface water bodies, could pose a threat of eutrophication.

Adequate facilities and services for collection, transportation, treatment and disposal of urban domestic faecal sludge are non-existent in majority of Indian cities. Most OSSs are emptied manually in absence of suitable equipment by scavengers. Ideally a septic tank system should be desludged regularly every 2-5 years. But ignorance towards Operation and Maintenance (O&M) procedures often results in accumulation of sludge at the bottom reducing the effective tank volume which leads to an overflow. This sequence of events ultimately causes failure of the system and release of partially treated or untreated faecal sludge from the septic tank. Private cesspool vehicle operators often do not transport and dispose of faecal sludge several kilometres away from human settlements or in a Sewage Treatment Plant (if existing) and instead dump it in drains, waterways, open land, and agricultural fields.

1.1 Project Background

National Institute of Urban Affairs (NIUA) is a premier institute for research, capacity building and dissemination of knowledge for the urban sector in India. NIUA supported by the Bill and Melinda Gates Foundation, is taking up capacity building activities under the Sanitation Capacity Building Platform (SCBP). A Technical Activity (TA) under this platform is to provide *"Faecal Sludge Management Solutions for two cities in India-Unnao(Uttar Pradesh) and Bhagalpur (Bihar)."* This Technical Activity is referred to as the Project throughout this report.

Objectives

The purpose of this project *"Is to build the capacity of cities and other stakeholders working in urban sanitation to ensure improved delivery of sanitation services through decentralized approach*." NIUA in coordination with CDD Society will support the on-going efforts of the Bill and Melinda Gates Foundation in demonstrating faecal sludge management solutions for tier 3 cities in northern India. The Activity, under the project, is to specifically provide faecal sludge management solutions for Bhagalpur city in Bihar.

Scope of DPR

The scope of this DPR is to assess the current gaps in sanitation across the city of Bhagalpur and suggest sustainable and cost effective ways to manage faecal sludge generated within its boundaries. Furthermore, the DPR also estimates the quality and quantity of faecal sludge generated from the city and proposes a treatment solution. It includes the detailed design notes for each part of the treatment module and the cost estimations for implementing the same.

This DPR in brief provides solutions for management across the value chain such as appropriate design of onsite sanitation systems, options for collection and conveyance and resue of treated end products. It however details the technical components of the treatment plant for the purpose of tendering out civil

constructions. Additional components of the FSM such as sustainable business models and capacity building planning would be provided in due course of time once the DPR is approved and additional information on funding and finances are available.

2. Need for Faecal Sludge Management

Bhagalpur is a city located on the southern alluvial plains of River Ganga, 220 km east of Patna and 410 km North West of Kolkata. The geographic position of the city had fueled its growth over the last couple of years. As per the 2011 Census, Bhagalpur has recorded a decadal population growth of 25.36 % as compared to the population in 2001. This growth had led to extensive burden on land with Bhagalpur having a population density of 1182.5 persons per Sq. kilometer as compared to a national average of 382. Such inorganic growth of the city has given very limited time for planning housing and other public utilities, thereby streets remain constricted and wastewater mostly managed at the household level by means of onsite sanitation system.

Currently, majority of the households rely on on-site sanitation systems such as septic tanks and pits to contain and partially treat black-water that is generated. Septic tank and pits overflowing into storm water drains or manmade pathways are quite prevalent. In addition grey water from household is also discharged in the same drain flowing outside or nearby. Such drains ultimately end up in the Ganges travelling through small rivulets or natural drains and add tons of nutrients, pathogens and organic pollution into it.

Figure 1: Outlet of Containment Units overflowing into drains

Bhagalpur has a very high groundwater table between 2-5 meter below ground level (Board, 2014-15) and studies have shown presence of excessive nitrates in the ground water (> 45 mg/litre) (Board, Ground water quality in shallow aquifers of India, 2010). Nitrate contamination in the ground is attributed to percolate from onsite sanitation systems and sewage from other nonpoint sources entering into these underground aquifers. This is an indication of unscientific onsite sanitation systems. Presence of such high ground water table can also pose threat of pathogen contamination from such containment units and lead to severe health risk.

The city has invested in procuring desludging vehicles to collect faecal sludge from such onsite containment systems as and when they get filled. Nevertheless the sludge transported by these vehicles is disposed in open drains or water bodies failing the entire sanitation value chain.

The above problems of extensive urbanization, unplanned growth, and unscientific onsite sanitation systems coupled with high ground water table pose a severe health and environment risk due to improper sanitation and wastewater management.

Figure 2: Desludging Vehicle

Figure 3: Desludging Activity in Bhagalpur

Efforts are being made to intercept drains flowing into the Ganges and treat the wastewater, but not much is being done in regards to wastewater generated at household level and for sludge collected from on-site systems. Faecal sludge management hence becomes imperative for such a context, especially when resources are constricted for sewerage based approach to sanitation. Faecal sludge management intends to cut leakages in the sanitation value chain especially those from on-site sanitation systems. It uses systems approach in integrating various actors and components of the value chain and aligning their objectives towards a safe and healthier environment.

3. Research Methodology

This section details the methodology used in assessing the current sanitation situation and gaps in wastewater management in the city of Bhagalpur. Data was collected through below mentioned means:

- Primary data survey
- Interviews and discussions with stakeholders linked to water and sanitation
- Review of secondary data

3.1 Survey Methodology – Baseline Study

CDD Society carried out a baseline survey of sanitation infrastructure and services in Bhagalpur (Uttar Pradesh). The details of the research methodology used in carrying out the study at Bhagalpur are explained below:

Objective of the study

The broad objectives of the study is as follows

1. To document the existing conditions of sanitation infrastructure related to treatment, collection, transportation and reuse of faecal sludge along the entire value chain
2. To identify enabling conditions for faecal sludge management
3. To conduct prefeasibility for establishing a faecal sludge treatment plant, thereby identifying boundary conditions.

Outcome of Study

The outcome of the study would be to identify gaps in the faecal sludge value chain and propose interventions which are appropriate and contextual that can bridge the gaps especially in faecal sludge treatment and reuse.

Stakeholders

The study includes stakeholders who play a vital role in the faecal sludge value chain. The below table enlists the stakeholders and their involvement in faecal sludge management.

Table 1: Stakeholders associated with infrastructure creation

Component	Stakeholder	Participation
User interface and containment structures-	Household members ULB	1. Primary custodian of the system 2. User of the infrastructure 3. Operates and maintains the system
	Non-residential places ULB	1. Primary custodian of the system 2. User of the infrastructure 3. Operates and maintains the system 4. Provision and O&M of common infrastructure
Desludging and transportation	Household members	1. Primary custodian of assets 2. Recipient of service
	Cesspool operator ULB	1. Service provider and custodian of desludging and transporting infrastructure.
Reuse	ULB	1. Information for faecal sludge for reuse at farm lands

Primary data collection

Objective and scope of survey

Primary data collection usually involves direct interactions with the stakeholder groups. Direct interactions reveal data which have not been previously capture by secondary data sources or such data sources are not relevant to present context. The primary objective of the survey was to capture information on infrastructure and operations of components across the value chain such as toilets, on-site sanitation systems, desludging and transportation vehicles etc. This information aids in planning effective solutions for FSM. Secondary objective of the study included understanding the receptiveness and support systems that exist in enabling such proposed interventions.

Surveys, semi structured, structured interviews and unobstructed observations are a part of the primary data collection process. While a structured interview would pose the interviewee with options and multi choices, semi structured questionnaires would have open ended questions that capture opinions and comments. Primary surveys were conducted for a statistically representative portion of the population. The respondent group for the survey were actors from the stakeholders enlisted in table 1. Table 2 presents the different data collection instruments used, the sample universe, sampling methodology and sample collection process.

Table 2 provides a summary of the methodology used.

Table 2: Study design primary data collection

	Survey Universe (N)	Sampling methodology	Sample collection
Household survey	Households in the project area with individual toilets	Quota sampling[1]	Structured interview Direct observations of the infrastructure
Non-residential survey	Commercial establishments, institutions and industries with individual toilets	Judgemental sampling[2]	Structured interview Direct observations of the infrastructure .
Interviews with key stakeholders	Identified stakeholders within the project areas	Snowballing[3] sampling	Structured interviews Direct observations of the operation (Desludging, transportation and disposal)

Sampling methodology

Household: Households are information sources on toilets, onsite sanitation infrastructure and collection mechanism for faecal sludge. It is important from a planning perspective to involve different segments of the population and propose interventions encompassing them. The sampling plan for primary survey hence

[1] Quota sampling is a technique where the sample universe is stratified based on a variable; in this case it has been roof type of the household. Once stratified, judgement of the surveyor is used to select the sample

[2] It is technique where the judgement of the surveyor is used to select the sample

[3] It is a technique where one sample leads or informs about the other sample

ensures representation of various socio economic segments of the population within the city. Sample universe, i.e. population constituting the sample space from which samples are chosen, consisted of households which had toilets and where connected to an onsite sanitation system. It is important to note that households without access to toilets and households connected to sewer networks were not a part of this survey since the primary objective of the survey is to plan for faecal sludge which is generated from onsite systems. Nevertheless households without toilets have been considered during analysis for estimating their future potential of contributing to faecal sludge generation.

Sample universe of households were further stratified for obtaining a weighted representation of the city. The stratifying variable used was socio economic condition of the household. Socio-economic condition largely determines the facility and the operations of sanitation infrastructure at the household level, and it is for this reason such a variable was chosen. The indicator to represent the socio economic condition was identified as the type of household roof, as this presented a fair indicator compared to others in the Indian decadal census.

Non-residential: These constitute institutions, establishments and other commercial ventures which have a toilet within their business premises and are connected to onsite sanitation systems. The sampling technique applied was judgmental sampling; samples were selected depending on the judgement of the surveyor.

ULBs: Bhagalpur municipality has a well-established office with an engineering department which provides for water supply and sanitation with the municipal limits. ULBs possess information on the business of cesspool operations owned by it and also on various monitoring and enforcement mechanism to ensure safe health and environment.

Cesspool Operators: Cesspool operators are key information source on the collection, transportation and disposal of faecal sludge. The sampling technique applied was snowballing. A list of cesspool operators were identified during interaction with the local community, and subsequent operators were identified for interview from the network or linkages from the list.

Table 3: Sample size for survey in Bhagalpur

Stakeholder	No of Samples
Households	377
Non-residential places	30
ULBs	1
Cesspool operator	1

Sample Size Calculations for Residential Surveys

Survey Universe

The survey universe as mentioned above includes all households with toilets and connected to onsite sanitation systems. Table 4 provides the number of households in the sample universe.

Table 4: Sample universe calculation

Source: Census 2011. Calculations by CDD Society 2016

City	No. of households	% of households with toilets	No of households with toilets (N)
Bhagalpur	69,984	81.70%	57177

A statistical method provided by William G. Cochran was adopted to calculate the sample size from the sample universe. Figure 1 describes the formula used:

Figure 4: Formula by William G. Cochran (1953)

$$n = \frac{\frac{Z^2 * p * q}{e^2}}{\left(1 + \frac{\frac{Z^2 * p * q}{e^2} - 1}{N}\right)}$$

n = sample size

z = standard normal distribution for the requested certainty of the confidence interval

e = probability of error

p = range of variation

a =1-n

The following assumptions are made for the calculation of sample size:

- A 95% confidence interval and a probability of error (e) of 5% are used.
- The range of variation (p) is estimated from 2011 Indian census, the proportion of septic tanks to the total number of households with toilets is used as the benchmark.

The following table depicts the sample size calculated for the survey in Bhagalpur using the formula stated above (Table 5).

Table 5: Estimated sample size for residential users.

Source: Census 2011. Calculations by CDD Society 2016

City	No of households with toilets (N)	p	Sample size (n)	
			e=5%	% of sample universe
Bhagalpur	69984	0.557	377	0.5%

Samples sizes were calculated separately for each ward, there are 29 wards in Bhagalpur.

Sample size for each ward for each ward = (Proportion of toilets in the ward to the total toilets in Bhagalpur city) X **"n"**

Where:

"n" is the total sample size for Bhagalpur =377

% of Households with Toilets in each ward = No of Households in each ward x % of Households with Toilets for entire Bhagalpur

Table 6: Ward-wise sample size for residential users.

Source: Census 2011. Calculations by CDD Society 2015

Ward	No		No. of households	No of households with toilets (N)	% of households with toilets	sample size (n)
Bhagalpur	1		1666	1361	2.38%	9
	2		1118	913	1.60%	6
	3		1209	988	1.73%	7
	4		1209	988	1.73%	7
	5		1468	1199	2.10%	8
	6		1413	1154	2.02%	8
	7		1198	979	1.71%	6
	8		1478	1208	2.11%	8
	9		1318	1077	1.88%	7
	10		1391	1136	1.99%	7
	11		1214	992	1.73%	7
	12		1389	1135	1.98%	7
	13		1370	1119	1.96%	7
	14		1474	1204	2.11%	8
	15		1246	1018	1.78%	7
	16		1513	1236	2.16%	8
	17		1026	838	1.47%	6
	18		1401	1145	2.00%	8
	19		1166	953	1.67%	6
	20		1373	1122	1.96%	7
	21		1108	905	1.58%	6
	22		1393	1138	1.99%	7
	23		1374	1123	1.96%	7
	24		1543	1261	2.20%	8
	25		1104	902	1.58%	6
	26		1740	1422	2.49%	9
	27		1423	1163	2.03%	8
	28		1646	1345	2.35%	9
	29		1723	1408	2.46%	9
	30		688	562	0.98%	4
	31		1797	1468	2.57%	10
	32		931	761	1.33%	5
	33		1856	1516	2.65%	10
	34		1430	1168	2.04%	8
	35		1085	886	1.55%	6
	36		1242	1015	1.77%	7
	37		1472	1203	2.10%	8
	38		1104	902	1.58%	6
	39		1046	855	1.49%	6
	40		1140	931	1.63%	6
	41		1307	1068	1.87%	7
	42		1501	1226	2.14%	8
	43		1766	1443	2.52%	10

	44		1417	1158	2.02%	8
	45		1260	1029	1.80%	7
	46		1236	1010	1.77%	7
	47		1728	1412	2.47%	9
	48		1630	1332	2.33%	9
	49		1371	1120	1.96%	7
	50		1617	1321	2.31%	9
	51		1666	1361	2.38%	9
	Total		**69,984**	**57,177**	**100%**	**377**

Table 7 shows the sample size of each ward for residential survey. The sample size at the ward level is further stratified based on the household roof structure; this is assumed to be a proxy indicator of the socio-economic condition. Once stratified at ward level, the survey team would use its judgement in selecting the households in each of strata to fulfil the

Therefore the number of households to be survey under each roof structure is calculated using;

= Sample Size of each Ward X Percent of households in each ward under each roof category

(The percent of households in each ward under each roof category was obtained from Census 2011 data)

Figure 5: Survey of Households

Table 7: Ward wise quota sampling plan residential users

Source: Census 2011. Calculations by CDD Society 2015

NO	Grass/ Thatch/ Bamboo/ Wood/Mud etc.	Plastic/ Polythene	Hand made Tiles	Machine made Tiles	Burnt Brick	Stone/ Slate	G.I./Metal/ Asbestos sheets	Concrete	Any other material
Bhagalpur									
1	1	0	1	1	0	0	1	4	0
2	1	0	1	0	0	0	0	4	0
3	1	0	1	0	1	0	0	3	0
4	0	0	2	1	0	1	0	3	0
5	0	0	1	1	0	0	0	5	0
6	1	0	1	1	0	0	0	3	0

7	1	0	3	0	0	0	0	2	0
8	1	0	2	0	1	1	0	3	0
9	1	0	3	0	0	0	0	3	0
10	1	0	2	0	0	0	0	3	0
11	0	0	2	0	0	0	0	4	0
12	0	0	2	1	0	0	0	4	0
13	1	0	2	1	1	0	0	2	0
14	0	0	2	0	0	0	0	5	0
15	0	0	1	0	0	0	0	4	0
16	1	0	1	0	1	0	0	5	0
17	0	0	1	0	0	0	0	3	0
18	0	0	1	0	0	0	0	5	0
19	0	0	1	0	0	0	0	5	0
20	0	0	0	0	0	0	0	6	0
21	0	0	0	0	0	0	0	5	0
22	0	0	0	0	0	0	0	6	0
23	0	0	0	0	0	0	0	7	0
24	1	0	1	0	0	0	0	6	0
25	0	0	1	0	0	0	0	4	0
26	1	0	2	0	0	0	0	5	0
27	1	0	1	1	0	0	0	4	0
28	1	0	2	2	0	0	1	4	0
29	1	0	2	0	1	0	0	6	0
30	0	0	0	0	0	0	0	3	0
31	1	0	1	0	0	1	0	6	0
32	0	0	0	0	0	0	1	4	0
33	1	0	2	0	2	1	0	4	0
34	0	0	1	0	2	1	0	3	0
35	0	0	1	0	0	0	0	4	0
36	0	0	0	0	1	1	0	4	0
37	0	0	1	0	1	1	0	4	0
38	0	0	0	0	0	0	0	5	0
39	0	0	1	1	0	0	0	3	0
40	0	0	1	0	0	0	0	4	0
41	0	0	1	0	0	0	0	4	0
42	0	0	3	0	0	0	0	4	0
43	1	0	3	0	1	1	0	4	0
44	1	0	2	0	0	1	0	3	0
45	1	0	2	0	0	0	0	4	0
46	0	0	0	0	0	0	0	5	0
47	1	0	1	1	0	0	1	6	0
48	1	0	1	0	1	0	0	5	0
49	0	0	1	1	0	0	0	5	0
50	0	0	1	1	0	0	0	6	0
51	1	1	2	0	0	0	0	4	0
TOTAL	**26**	**6**	**64**	**15**	**16**	**16**	**14**	**217**	**2**

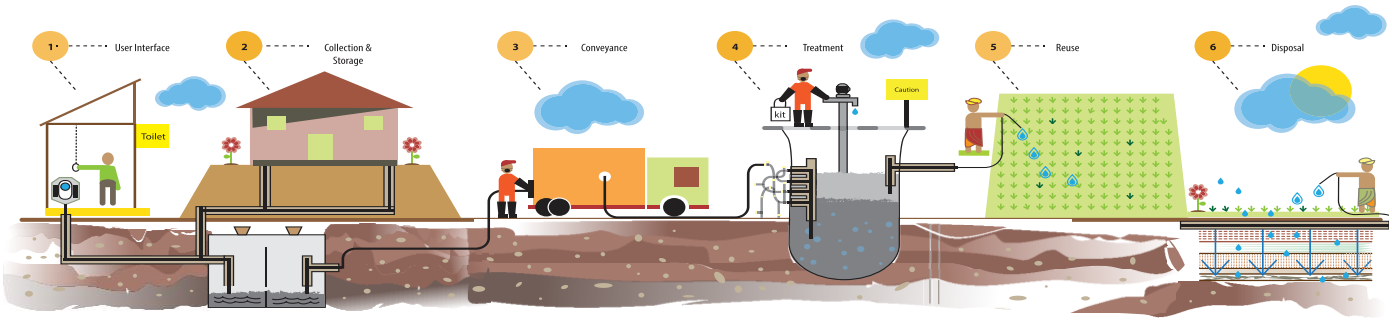
Sample Size Calculation for Non-residential Units, Cesspool Operators, and ULBs

A survey with commercial establishments, institutions and industries (non-residential users) completes the data generated in the primary survey. In the same way like households with an individual toilet, only non-residential establishments with these facilities belong to the target group of the survey. As a result of a lack of reliable data concerning the numbers of establishments as well as about the toilet facilities, the target group cannot be described in concrete numbers. For that reason, the sampling strategy between residential and non-residential users differs. For this study we will use the snowballing sampling technique to survey Cesspool Operators. Non-residential samples were selected based on the judgement of the surveyor.

4. Situation Analysis

To understand the existing sanitation situation in Bhagalpur city, faecal sludge value chain approach was used. Faecal sludge value chain is the linear linkage of dependent components in the pathway of faecal sludge generated from onsite sanitation system. The value chain has components such as user interface, containment, collection and conveyance, treatment and reuse. Figure 3 shows a schematic representation of the value chain.

Figure 6: Faecal Sludge value chain



The management of this value chain is termed as Faecal Sludge Management (FSM). FSM is an important and incremental approach catering to improved sanitation. In the past, faecal sludge management from onsite facilities has not been a major priority for engineers or municipalities, and has traditionally received little attention. Several generations of engineers have considered waterborne, sewer-based systems as the optimum, long-term solution to fulfil sanitation needs. Onsite technologies have been looked upon as only temporary solutions until sewers could be built. It is a common perception that onsite technologies fulfil sanitation needs for rural areas, but in reality, around one billion onsite facilities worldwide are in urban areas. In many cities, onsite technologies have much wider coverage than sewer systems. Given that cities are expanding at an incremental rate and that the scope of funding from public sector remains unchanged, the plan to have all households connected to a sewer network remains a distant goal to be achieved. It is the cost and effort involved in constructing sewerage networks and associated treatment plants which lead practitioners and researchers in the field to think about a novel approach, thus mainstreaming FSM.

4.1 Bhagalpur- Existing Situation in Bhagalpur

Bhagalpur city is also the headquarters of Bhagalpur district. The District lies between latitude 25° 15' 0" N and longitude 87° 0' 0" E. Bhagalpur is 215 km away from the capital of Bihar, Patna.

Table 8: Population Information

Population	
Total	400,146
Male	212,813
Female	187,333
Decadal Population Growth Rate	25.36%
Population Density	1180 person per sq km
Total No of Households	69984

Topography and Climate

Bihar lies on the Indo-Gangetic plains having typical characteristics of flat and alluvial soil. Most parts of the city are flat with slopes near the banks of river. The soil is mainly loamly and rich in organic content, rejuvenated every year by constant deposition of silt, clay and sand brought by river streams and by floods in Bihar.

The temperature in Bhagalpur varies widely between summer and winter seasons. During summers temperatures raise up to 45 degree and during winters the temperature falls to 5-6 degrees.

Table 10 below gives the climate information for Bhagalpur City.

Table 9: Climate Information

Climate Information	
Hottest Month	May (31.5 °C avg)
Coldest Month	January (17.1 °C avg)
Wettest Month	July (249 mm avg)
Windiest Month	May (11 km/h avg)
Annual Rainfall	1111 mm (per year)
Average Humidity	69%

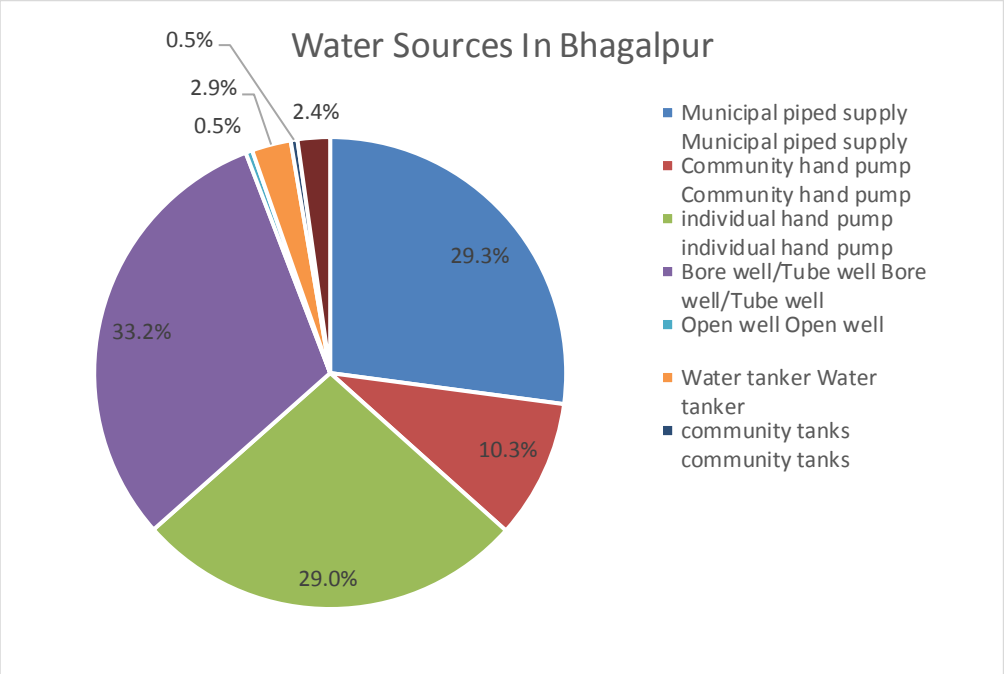
Water Supply

Current Situation

According to the ULB, around 18,000 holdings have access to piped water, supplied by the ULB. Around 50 lakh gallon of water is supplied to the citizens per day. There are 7 active overhead tanks in the city of capacities 50 KLD each from which water is supplied twice daily.

Ground water table in Bhagalpur is high and between 2-5 meters below ground level, this has enabled many households to have secondary source of water other than the one supplied by ULB. Most use of the secondary source was for non-portable purpose such as washing and cleaning. While only 18000 households had access to piped water supply, others relied on community hand pumps installed by the ULB or had a private arrangement such as bore-well or tube well. 33.2% of households claimed to have access to bore well within their premises, 29% households had access to individual hand pumps and similarly 11% households had access to community hand pumps.

Table 10: Water Sources as per Survey 2017



User Interface and containment

According to 2011 census, Bhagalpur had an individual toilet coverage of 81.7%, while the remaining households either had access to community/public toilets or defecated in open. It was also observed during the survey that a few households did not have containment systems attached to the toilet, rather all the black water ended up in a drain or water body near to the house. 82.7% of the toilets had pour flush arrangement, while the remaining were cistern flush. Comfort to use and lack of piped water supply for cistern flush were major reasons cited for prevalence of pour flush toilets. Household which did not have piped water supply had provisions to carry water for flushing and cleansing from an outside water storage.

In the survey conducted, 90 % households had rectangular leach pits as containment for black water, while the remaining 10 % were connected to pits. Septic Tanks were found to be more common in city areas where as pits were seen to be constructed more in economically weaker areas/ peri-urban areas which could not afford septic tanks.

Figure 7: Toilet with Containment Units

78% of the Rectangular containment units' resembled septic tanks in the construction and had elements such as baffle wall, these tanks were common across the clusters as they had huge storage volumes, which were indeed preferred by the household. The sizes of these tanks varied between 2 – 57 M^3. In general the depth of these tanks varies between 3 – 15 feet. 78 % of these tanks claimed to be lined at the bottom, while 85 % of septic tanks claimed to have watertight walls.

Only 57 % of these tanks had easy access to desludging i.e. had an opening for desludging and access road more than 3 metre. Most of the tanks had a manhole access for inspection or desludging, but these remained closed at the time of conducting this survey, they were plastered in the edges using cement and had to be opened by breaking open this seal arrangement. The design has not taken into proper

consideration easy access for desludging hence making it inconvenient for the desludging operators to access the septic tanks for desludging.

Around 55.72 % of the septic tanks had their outlets connected to open drains while 18% of these tanks didn't have outlets. It was also seen that around 61 % of the Septic tanks were not desludged while 28% of the HHs claimed that their septic tanks were desludged. The below table depicts the frequency of desludging for the surveyed containment units.

Figure 8: Outlet of a containment unit drains directly onto the drains in the street

Figure 9: Outlet of a containment unit drains directly into a drain

Single pits were predominant compared to twin pits; there are only a few twin pits present in the city. A probable reason for this is the lack of area availability to construct twin pit.

Single Pits varied in volume ranging from 0.8 to 8 M^3, while the diameter and depths were in the range of 1–2 meters. 31% of these single pits had their covers temporarily fixed while 61% of the covers were cemented to the pit and the remaining 8% had no covers. All the households, which had single pits, claimed that there wasn't an outlet in the pit through which the faecal matter overflowed.

Most of the pits and septic tanks weren't designed as per the standards required and they do not have any provision for desludging.

Collection and Transportation

This section covers the infrastructure and systems in place for collection and transportation of faecal sludge generated from household containment units to disposal points. There are two tractor mounted vacuum based desludging vehicle owner by the ULB which service the demand for desludging from households and non residential units within the limits of Bhagalpur municipal corporation.

During the study it was found that 55 % of the household who had desludged, used non-mechanized means to remove sludge from the containment units. Non-mechanized means included manually lifting the sludge by means of a bucket or shovel etc. These means were a common practice among a few social groups, who carried this as an alternate occupation. The study could not document any such manual emptying practice

as most such operations happened over night or in a clandestine manner. The sludge removed through these non-mechanized means was often disposed in nearby surroundings or storm water drains. The cost of non-mechanized desludging varied between Rs. 2000 to 5000 depending upon the number of people employed for the job. The most common reasons provided by households for pursuing such non-mechanized desludging in spite of high costs were:

a. Non-approachability of vacuum trucks due to narrow approach roads.
b. Delayed response by the government vacuum truck
c. Lack of knowledge on such a facility by the ULB

The rest 45% of households who had claim to desludge, use the vacuum suction machine available with the ULB. A few households in the periphery fringes of Bhagalpur also admitted getting their containmentunits cleaned by private operators from nearby towns and cities.

Figure 10: Cesspool Operator Vehicle

The ULB vacuum truck charges Rs. 1600 per trip of desludging service. Each trip can accommodate up to 4000 liters of sludge. At a few instances it was also observed that when the sludge quantities to be removed from containment system were high, the vacuum machine sucked the sludge from containment unit and disposed in nearby storm water drains, there by acting just as a suction devise and eliminating the means to transport sludge.

Household usually desludged when their pits/ tanks were filled or when there were unpleasant odor emanating from the toilet or containment unit. In such cases, households would approach the ULB and register a service request. Based on the availability of the vehicle, the service appointment would be provided. Desludging operators, usually on rolls of the ULB would pick the service request receipt along with the mobile number of the customer and seek clarification on the address and approach. At times, it was not possible for the desludging operation to be carried out due to narrow roads or because the sludge was too thick to be pumped out. At such instances the money collected by the ULB was refunded and the desludging operators would suggest alternate non-mechanized means for sludge removal.

For Municipal Operators, access to containment systems was a time consuming task in the entire operation of desludging, usually taking about 10-15 minutes in locating and opening an access point for desludging.

The HHs keep the man hole opened and after the desludging is complete, the broken top cover is left for the household to fix, who in-turn hire a construction worker or usually do it themselves.

The entire operation of desludging can last for about 10-15 minutes, depending upon the accessibility and thickness of the sludge to be pumped out. After opening the access a crow bar or a stick is inserted into the pit/tank to get an understanding on the thickness of the sludge. If the sludge is thick then water is poured usually through the toilet pan and mixed with the crowbar till it can be pumped out. Vacuum suction is the most prevalent means of desludging in Bhagalpur; operators can empty 3 – 4 m^3 of sludge in 10 minutes (this excludes the time in breaking open the access point). Solid waste such as polythene, condoms, stones were present in the pits/tanks can choke or block the suction pipes, but no choking was observed during the desludging operation. Municipal operators used flexible pipes for suction, made of PVC and were 50 feet in length and 3 inch in diameter.

During the study period it was observed that one of the two trucks belonging to the ULB had developed a technical snag and has been lying with the mechanic for more than a month. This was also a reason for ULB not being able to service 100% of the desludging requests.

In a month, the trucks owned by the ULB would service around 30 -40 households generating a revenue of Rs.48000 – 64000. The revenue and cost were accounted in a miscelanoeus account held by the ULB, catering to other transactions as well, and hence there was no clarity on the profitablilty of this service model.

Disposal and Reuse

The collected faecal sludge from containment units is either disposed in storm water drains or in vacant lands. There are also instances where the private operators dispose in vacant lands on the banks of river Ganges. Traditionally the ULB had carried out the process of trenching for faecal sludge in vacant lands away from habitation and water bodies, but this procedure was discontinued due to non-availability of land.

During the study, it was found that a few farmers accept faecal sludge application in their farmlands for improving the soil fertility and properties, but such applications are usually carried out by private desludging operators and at farming seasons. Probing further and interactions with farmer community revealed that such a practice is not prevalent and only a handful farmers accepted faecal sludge.

Solid waste

There is no door-to-door solid waste collection in city. Some of the households dump the solid waste at a location in their neighborhood and burn it, while a few households have a dedicated dustbin in each ward and the solid waste from these community bins are collected periodically by the municipality using their own trucks.

Drainage system

Bhagalpur is divided into 3 zones based on the topography. Zone A extends from the centre to the western part, Zone B extends from the centre to eastern part and Zone C extends from beyond the railway track to southern part. Wastewater flowing through open drains in Zone A is intercepted and pumped through sewer lines through which it flows to a wastewater treatment plant. Currently the wastewater treatment plant is

dysfunctional owing to maintenance issues and also the wastewater to treatment plant is erratic due to maintenance issues in upstream pumping station.

FSM Gap Identification

From the above situation analysis, gaps across the sanitation value chain as well as in the management framework can be highlighted as mentioned in Table 13 and 14.

Lack of 100 percent toilet coverage, poor design of pits and septic tanks, manual desludging, no faecal sludge and wastewater treatment and direct disposal on land or water bodies is posing severe environmental and health problem in the city.

Table 11: Gaps across Sanitation Value Chain in Unnao City

	Toilets	Collection	Conveyance	Treatment	Disposal / Reuse
Current	Open defecation and toilets connected directly to drains or water bodies	Unlined pits and septic tanks causing ground water and soil contamination; Overflow into surrounding areas; Bad odor; no information about correct design	Unscientific desludging and disposal; Waiting time; Expensive; Narrow lanes difficult for municipal vehicles to access households	Partial digestion in pit/septic tank Direct disposal on landfill sites or drains without treatment; Lack of awareness	Disposal of faecal sludge into drains No reuse or reuse without treatment
Gap	Need to improve access to toilets by encouraging individual toilet construction Toilets need to be connected to scientifically designed containment units	Need to train toilet builders on scientific design of containment structures and build awareness of improper design and operational practices.	Plan for appropriate desludging vehicles, which can access households in small lanes. Improve efficiency of existing infrastructure by better management of assets	Need for an appropriate treatment/safe disposal mechanism	Awareness on correct reuse practices

5. User Interface and Containment Units Recommendations

The responsibility of Faecal Sludge and Faecal sludge Management rests primarily with ULBs, with technical support from Jal Nigam in Bhagalpur. The private and informal sector wherever possible, should play the role of service provider for complete service chain of FSM within the overall regulatory framework of the ULBs.

Urban resident communities should follow the regulatory bye laws by urban local bodies, go for scheduled desludging for optimizing performance of their septic tank, construct septic tank as per designs advised by CPHEEO and ensure that effluent from septic tank finds way into seepage pits/ seepage trenches.
The ULBs should carry out awareness drive on FSM practices (design of septic tank, seepage pits , Health hazards etc.) and regulatory mechanisms (Schedule of Desludging, maximum rates of desludging, monitoring by citizens so that faecal sludge does not finds place in open environment, maximus rates payable by households for desludging , recycled resources recovered from waste and its availability etc.)

Below listed are a few steps that the ULB can take to assess the existing toilets and septic tanks and cancreate a database

- City level assessment of coverage of toilet and on-site sanitation facility using the existing database (like property tax module, Census 2011 etc.) or based on recent survey carried out under SBM.
- If the ULB do not have database, then ULB shall create database of toilets and septic tanks. Ideally, all ULB shall link the key result related to toilet availability, type of toilet and its connection with waste water outlet with property tax database on e-governance platform.
- ULB shall keep updated database related to toilet availability and on-site sanitation through property tax assessment survey carried out at every four years of interval
- Evaluate existing septic tank designs and other storage/treatment systems and modify (in case of variation) based on design mentioned in the design norms of CPHEEO Manual, (Refer Additional Document provided as part of DPR package). Notices should be issued to property owners whose septic tanks do not meet the standard septic tank design.
- ULB can include septic tank design & provision in master Plan approvals of buildings
- At places where individual soak pits cannot be built, common pits can be built where they can also soak away the grey water.
- Identify insanitary toilets and convert them to sanitary latrines for safe collection and disposal of waste as per norms set out in the design norms CPHEEO Manual.

6. Faecal Sludge Conveyance in Bhagalpur

Bhagalpur is served with on-site containment systems (OSS), i.e. septic tanks and pits. Cleaning of these septic tanks and pits is sporadic, and the faecal sludge (FS) collected from such containment units are dumped into the environment, untreated, leading to pollution of land and water bodies and it is due to this reason the city is interested in introducing a fecal sludge treatment plant and reuse facilities.

Bhagalpur, requires a good quality, reliable faecal sludge transport and conveyance systems to ensure end-to-end Faecal Sludge Management services are provided by the city.

6.1 Overview and Computation

These figures are based on a preliminary assessment and Census, 2011 data and will change upon detailed analysis

Town	Bhagalpur
Approx. Number of Households	69,984
Number of HH having sewer connections	3863
HH having on-site containment	45,245
HH without toilet(OD)	18,196
HH using public toilet	159
Number of cesspool vehicles present in the town	1 operational & 1 to be repaired
Volume of the cesspool vehicles operating	Each of 3500 Lts
Average size of the septic tank/pit**	6.62 Cubic metre
Capacity of proposed Faecal sludge treatment plant per day	32 cubic metre (Refer Section 8)

*based on the survey done with 377 HH in Bhagalpur

**based on the survey done with 377 HH and 2 cesspool vehicle operator

6.2 Intervention and Implications Proposal

Four major gaps were identified in the existing transport and conveyance of faecal sludge in Bhagalpur based on the survey done by CDD Society.

- Many of pits /Septic tanks are not accessible due to narrow road lanes
- Existing of gap between demand and supply of desludging services provided by the ULB as government vehicle is not able to cater to the existing demand. On an average, daily about 4-5 calls for desludging are received but only 1-2 desludging orders are being attended per day due to non-availability of cesspool truck
- Disposal of faecal matter at improper sites: currently, the faecal sludge collected has no fixed disposal site. Most of the times, it is disposed of in open drains or in open space in an around 'Tatarpur' location.
- Involvement of non-mechanized desludging for cleaning the septic tank/pit because of non-availability of desludging service on time and also due to inaccessibility of septic tank/pit with the existing cesspool vehicle because of size restrictions.

For implementing the faecal sludge transport and conveyance, developing and adopting appropriate technologies will become increasingly critical to manage the vast operations for these OSS and also to ensure consistent service quality to citizens and to enable monitoring by relevant authorities.

The most important stakeholder of the on-site sanitation chain are the urban local bodies who operate vacuum trucks, to empty the OSS when it gets filled, and transport the faecal sludge either to a faecal sludge treatment plant, or dump the sludge on open land or in water bodies. Technology is critical to bring quality, consistency and compliance to this activity.

Based on a study done by CDD in Bhagalpur, four key actors were identified and the difficulties faced by each are discussed below.

1. Owner of the desludging services business(in this case, the service provider is the ULB)
    a) Difficult to monitor movement of trucks
    b) Difficult to monitor the quality and quantity of desludging service provided by driver/operator for the individual customers. Also, financial transactions like how much payment driver/operator is collecting is difficult to monitor
2. Truck driver / operator who actually delivers the service
    a) Finding the customer location can be difficult, leading to wasted time and potentially irritated customers
    b) Unsure about conditions at the customer location—for example, the septic tank cover may be sealed or inaccessible due to improper road axis. This would lead in
3. Customer availing the desludging service
    a) Complex procedure for lodging a request for desludging at the ULB office and unsure when the truck will arrive to desludge. The current practice which exists for availing the desludging service is to visit the ULB office, write a written complaint and pay the fixed amount of challan and submit the photocopy at the office. The service would be provided mostly after 2-3 days and in case the pit/septic tank couldn't be desludged then the amount paid would be refunded after 2-3 weeks of time.
    b) No customer complaint redressal mechanism is available. This would lead decrease in customer satisfaction because of poor quality of service delivered.
4. Government and regulators who want to safeguard the environment
    a) Tracking where operators dump the faecal sludge so that making sure the faecal sludge would reach the faecal sludge treatment plant completely.
    b) Monitoring the household's containment desludging frequency to match with design/O&M specifications as specified by CPHEEO guidelines and which have been extracted under SBM specifications for 5 people household.

One can integrate various technologies that are established and proven in other sectors, and are economical to use, which can be adapted to address many of these problems. A few of these are discussed below.

1. **Intelligent Maps:** Septic tanks / OSS can be mapped across the city and colour-tagged to identify last cleaned date. This data can be used to send notices to the owner or impose fines, as well as schedule cleaning services. Thus, it addresses (4b). These systems can be operated at the control center of desludging operators and the local municipal office. The status/data need to be updated based on the requests received day to day or by mapping the entire onsite sanitation systems at once initially.

2. **GPS Tracking Systems:** Installed on cesspool vehicles, these systems can help drivers find the best route to the customer destination (2a), help the owner track the truck location and get alerts if the truck makes unscheduled stops. The government can demand reports on such unscheduled stops to evaluate whether sludge was disposed at illegal spots (4a)

3. **Control Center:** It can accept the requests for desludging and for customer complaint redressal mechanism there by also collect the feedback from customers after the desludging service is provided. This would enhance the quality of service and also improve the customer satisfaction. This would ensure quality service to the customers (3b) and update to customers about the desludging service they requested (3a). Information can be collected from the customer in advance to avoid problems noted in (2b)

4. **Billing/payment systems:** These systems can be used to enable payment facilities at the desludging location itself and hence addresses the problem (3a). This also improves the transparency and keep a check of payments by proving invoice to the customer immediately. This would ease the payment and maintain the records properly.

5. **MIS Systems:** MIS tracking systems would be developed which would include dashboards capturing operations and maintenance costs of cesspool truck, monthly profit-loss statement, operations dashboard and sludge collected/treated.

Similar systems will be deployed on the trucks and control center established for Bhagalpur.

In order to strengthen the faecal sludge management and avoiding involvement of non-mechanical desludging for cleaning the septic tank, one needs to add more vehicles which would be able to cater the city in providing desludging services and also create awareness in the public about faecal sludge management..

6.3 Proposal by CDD

Existing infrastructure and scenario present in the faecal sludge transport and conveyance:

- There are two cesspool vehicles of capacity 3500 Lts each which are owned by ULB. Of these two cesspool vehicles, one is functional, the other cesspool truck is under repair and is not currently functional.
- The faecal sludge generation in Bhagalpur is 32 cubic metre based on the survey done by CDD Society.

By studying the existing infrastructure and gaps present in the faecal sludge transport and conveyance, we propose the following:

- Buying of four cesspool vehicles of different capacities as discussed below,

Table 12: Cesspool Vehicle Details

No. of cesspool vehicles	Capacity of vehicle in Lts	No. of trips per day*	Faecal sludge which can be collected per day in Lts
2*	3500	2	14000
2	1000	2	4000
1	2000	1	2000
1	6000	2	12000
		Total faecal sludge which can be collected	32000 Lts

* There are two cesspool vehicles of capacity 3500 Lts each already with the ULB. One vehicle is fully functional and other is under repair which can be used after the repairing is done.

**No. of trips per day is considered based on the survey done with cesspool vehicle operator and sanitary inspector.

Thus, one should add a fleet of four cesspool vehicles of one of 6000 Lts capacity, one of 2000 Lts capacity and two of 1000 Lts capacity each to the exiting to fleet of two cesspool vehicles of 3500 Lts capacity each.

- Integrate the trucks with G{S technology and billing/payment systems which addresses the issues faced by multiple stakeholders.
- Establish MIS systems and call center to receive orders, track, monitor and maintain the records of desludging services provided. This will also act as mechanism for customer complaint redressal.

Financial Requirement for faecal sludge transport and conveyance:

Table 13: Financial Requirement for faecal sludge transport and conveyance:

Sl.No	Details		Financial Requirements estimation for one vehicle
1	Cesspool Vehicle	1000 Lts Capacity	10 Lakh INR*
		2000 Lts Capacity	15 Lakh INR*
		6000 Lts Capacity	30 Lakh INR*
2	Operation & maintenance of cesspool truck/sucking machine including GPS and GPS tracking per annum		7.3 Lakh INR **

Table 14: Truck Operations Cost

B	**Providing operation & maintenance of truck/sucking machine** i.e., that includes regular repairs and maintenance, operations, human resource cost and other activities.				
Description		**Unit**	**Quantity**	**Rate**	**Amount in Rs./annum**
B.1	Providing human resource for maintenance for cesspool vehicle regular operations and maintenance(Driver operator)	Man days	6.no	6*365*442	967,980
			6.no	6*365*442	967,980
B.2	Cesspool vehicle maintenance and repair such that includes, i.e Painting, general engine repair,tyre change, wheel allignment,FC,engine oil change, coolant and other minor repairs	1	1	75,650.00	75,650
B.3	Providing fuel for truck operations	Rs.60/ltrs	6 litres/day	6*60*300	54,000
B.4.	Regular maintenance of sucking pump such that includes oil, greasing, valvechange, rubber and pipe change.	Rs.337/day	-	337*365*1	123,000
B.5.	Incidental maintenance of truck such includes travel, othermiscellaneous costs	Rs.4000/month	-	4000*12	48,000
B.6.	Capital investment cost for technology based operationsoptimization such that includes installation of GPS,GPS tracker, softwaresubscription, phone bill for call centeroperations, online payment portals	Rs.8000/month	1	8000*12	96,000
B.7.	Provide safety gears for driver and operator such that includes(Facemask,helmet,pair of safety gloves, pair or gumboots and other special equipment's for operator	Rs.2500/person	6	2500*6	15,000
Total truck operations cost					**23,47,610**

*Rates derived from market

7. Capacity Building for implementing FSM in Bhagalpur

Appropriate and adequate management of faecal sludge from on-site containment systems is imperative for the protection of human and environmental health. Through these various capacity building activities, we intend to strengthen the knowledge and skills of the officials working with the various town municipalities on various aspects of Faecal Sludge Management.

7.1 Workshops

We propose various capacity building activities through workshops which would address the current knowledge elements of this rapidly evolving field, and present an integrated solutions approach that includes technology, management and planning. It will focus on the planning and organisation of the entire faecal sludge management service chain, from the collection and transport of sludge and treatment options, to the final end-use or disposal of treated sludge.

In addition to providing fundamentals and an overview of technologies, the workshop will go into details of operational, institutional and financial aspects, and will provide guidance on how to plan a city-level faecal sludge management project with the involvement of all stakeholders.

The objectives of these proposed workshops is to:

- To provide participants with technical and practical knowledge and skills on the concept and principles of design and implementation of FSM in Indian context.
- To enable participants to gain knowledge and skills for systematic planning and implementation of a series of activities for collection, containment, transportation, treatment and safe disposal/reuse in FSM.

We propose 3 workshops as part of capacity building activities and both of them have different target groups and are aimed to achieve the objectives. The details of the workshops are discussed below.

Workshop on FSM

Introduction on FSM (1 day)

The one day workshop would be planned to provide a basic understanding of FSM to the officials of the cities. Upon completion of the one day workshop the participants will be able to appreciate the need of FSM in their city.

Target Group

Commissioners, Engineers & Planners of the cities who are involved in the management of sanitation infrastructures.

Introductory Workshop & Exposure visit on FSM (2 days)

The two day workshop is planned to provide customised inputs towards the potential of the FSM activities in the city. The workshop would provide in-depth understanding of the methodology involved in planning FSM for a city and the participants will be able to get first-hand experience about operations of a FSTP.

Target Group

City Commissioners and State level officials who are involved in the planning of sanitation in state and city levels.

7.2 Trainings

Training for Toilet Builders on Onsite Sanitation Systems (2 days)

Masons play a vital role in the overall faecal sludge value chain in construction of toilets and containment systems for the individual users in every city. The success of faecal sludge management in any city relies heavily on its on –site sanitation systems which includes the toilets, septic tanks, pits, etc. To ensure the sustainability of the activities, capacity building of the masons who are responsible for the construction of these facilities is mandatory.

The training is planned to create awareness on the significance of toilets in sanitation and it's impact on environmental protection, to provide Mason's with technical knowledge and skills on the design and principles of the Onsite Sanitation Systems (OSS) as specified under Swachh Bharat Mission, to familiarise the participants with the construction norms and the specific requirements for construction of OSS Systems and to stress on the importance of O& M of these OSS Systems in order to understand the role played by the elements of the OSS relevant to O&M.

Target Group

Masons working in the Bhagalpur who have been building toilets under the Swachh Bharat Mission

Training for cesspool vehicle operators on appropriate and safe usage of collection and conveyance mechanism (2 days)

A good quality, reliable faecal sludge transport and conveyance systems are required to ensure end-to-end Faecal Sludge Management services are provided by the city. The cesspool vehicle operators play an important role in the faecal sludge management.

The two day training is planned to provide overview of the technology for faecal sludge collection and conveyance. The activities are designed in such a way that the cesspool operators get a hands on experience with the technology which would strengthen the faecal sludge management. They will be provided with customised inputs towards the potential of the FSM activities in the city and how using the technology will help in addressing the key issues faced. The workshop would provide in-depth understanding of the technology and various aspects of undertaking a business/service in the form of desludging services for Bhagalpur.

Target Group

Cesspool operators working in the Bhagalpur who have been handling desludging services and also potential desludging services in order to develop the team.

8. Criteria Adopted For Design

8.1 Quantification of Faecal Sludge

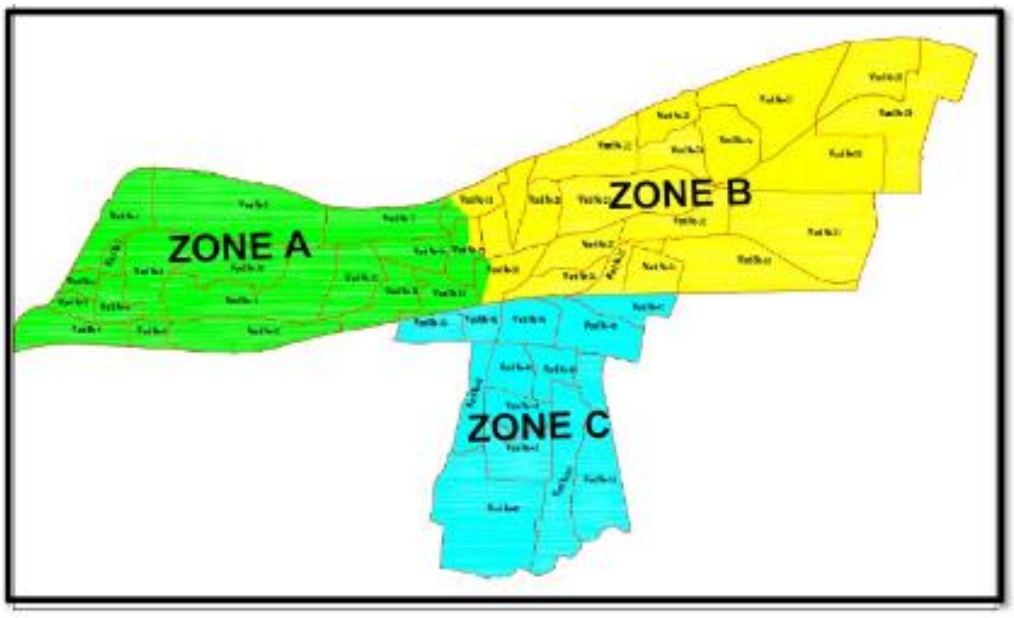
Accurate estimation of faecal sludge is important as it will determine the complete management mechanism right from desludging intervals, collection system, treatment modules, size of treatment unit, area required for treatment to the end-use of the treatment by-products. For the purpose of determining the quantity of faecal sludge receivable at the faecal sludge treatment facility, three different methods of estimations have been used. These different methods have been detailed below, the detailed calculations are shown in annexure 1:

Recent development in Bhagalpur

The total population of Bhagalpur in the year 2011, as per census was 4,00,146. Considering previous growth rates and estimating for the future, by the year 2027 the estimated population of the city would be 5,47,000. This assumes a decadal growth rate of 35% and floating population of 27,000.

According to the documents and details provided by officials of Bhagalpur Municipal Corporation, there is a proposal for a sewerage system along with a treatment plant to be implemented in Bhagalpur covering the entire city. TAHAL Consulting Engineers Limited, had prepared a Detail Project Report (DPR) for *Comprehensive Waste Water Management (Sewerage) in Bhagalpur, Bihar State* under NGRBA. The entire Sewerage Scheme of town was divided into two packages, Package consisting of Wards on the north-western portion of the town to accommodate their flow to the STP at existing Govt. Land. Remaining wards of Bhagalpur are covered under Package B. In this DPR, Bhagalpur was divided into 3 major Sewerage Districts, namely Zone A, Zone B and Zone C. Zone B and C were considered into Package B (i.e. this DPR) and Zone A was considered into Package A. For Zone A the land proposed for the STP is on the same land where an STP based on Aerated Lagoon system already exists.

Figure 11: Three Zones in Bhagalpur



As it is not clear when the proposed sewerage DPR will be implemented, it is recommended that a pilot treatment plant be set up initially for **one zone (Zone A) of Bhagalpur** as part of the land in the existing STP area is available for FSTP implementation. Based on the learning and experience of operating this facility, the treatment capacity can be augmented to for the remaining zones as and when the demand rises. Necessary considerations have been provided while designing the treatment systems to increase the capacity at the proposed facility if need arises

Since, the DPR is intented to compliment the proposed sewerage system, faecal sludge management planning is carried out only Zone A[4] (Wards 3,6,7,9,12,13,17,19,20,26,29) using the data and assumptions made above.

Below are the three methods for estimating the faecal sludge volume for the treatment plant handling:

Estimations using Primary data - volumetric

In this method, information collected from households in terms of containment sizes and desludging In this method, information collected from households in terms of containment sizes and desludging frequencies were used for estimating the faecal sludge collected at the city level.

Primary survey was used to arrive at data regarding size of pits or septic tanks and its volume, desludging interval, method of desludging and the last desludged period. The last desludged period validates the frequency of desludging data.

This information is used to determine the total sludge quantities expected to be loaded at the treatment facility (Explanation of calculation is provided in Annexure 1).

Volume of pits and septic tanks can estimate the quantities that will be stored during the desludging intervals. In addition, the capacity of the desludging vehicle and the average emptying frequency at household levels help estimate the quantities that will be collected and delivered to the treatment facility.

Estimates for volume of faecal sludge from household units:
The Total Volume of FS for HHs per day (m3) = Estimated FS desludged from surveyed households * Total number of households in 11 wards of Bhagalpur / Households surveyed

=1.04 * 27000/ 377

=**74.5 m^3 per day**,

Estimates for volume of faecal sludge from non residential units (in m^3) = Estimated FS desludged from surveyed non residential units* total number of non residential units in 11 wards / non residential units surveyed

=0.4* 75[5] / 13

[4] It is assumed that by the end of SBM program, all households in Bhagalpur will have a toilet with some form of containment system

[5] As per discussions from the ULB staff. Non residential units include only those with a facility for toilet

=**2.3 m^3 per day**

Hence, the total faecal sludge estimated for the city is 74.5 + 2.3 = 76.8, say 77 m^3 per day.

Note: For the purpose of calculation, households that have not desludged, their frequency has been assumed as 15 years.

Estimations using demand for faecal sludge collection

In this method , the faecal sludge to be received at the treatment plant is estimated based on the current collection volumes. For the calculation of current collection volumes, the survey team interacted with various desludging operators both private and public to determine the volumes hauled and number of trips. As per findings, the provision for desludging is provided by two operators, one by the ULB themselves while the other is a private operator based from Kanpur. The following calculation estimates the FS volume:

Current estimates of faecal sludge desludging demand in volume = number of vehicles servicing the city x volumes hauled by the truck x number of trips per day.

For Bhagalpur City as per the survey data there are two vehicles of capacities 3.5 m^3, then total volume of faecal sludge that can be desludged per day is:

a) For municipal 3.5 m3 vehicle= Capacity of Vehicle * No of trips per day * No of vehicles

   = 3.5 * 2 * 1= **7 m^3 per day**

b) For private 3.5 m3 vehicle= Capacity of Vehicle * No of trips per day * No of vehicles

   = 3.5 * 2 * 1= **7 m^3 per day**

Estimated volume of faecal sludge currently collected as per demand: 14 m^3

Assuming that in the design period of the FSTP, there will be a two fold increase in this demand the total volume would hence be 28 m^3 per day.

Estimations based on Population based FS Generation Rate

Under this method, faecal sludge generation is estimated based on sludge accumulation rate per capita provided by the CPHEEO manual for on site containment units.

Estimations using this method are calculated below:

Population of Zone A for the year 2027: 134,793 persons

Floating population assumed 2027 for Zone A: 7000 persons

Sludge accumulation rate in containment units as per CHPEEO : 0.00021 m^3 per person per day

Sludge accumulation rate per day for: 141793 x 0.00021 = 30 m^3

Estimation of treatment Quantity

The below table summaries the estimates of faecal sludge determined using the above three methods:

Table 15: FS Quantity from three methods

Method of estimation	Estimated FS volume per day
Primary survey - Volumetric	77 m^3
Demand based estimation	28 m^3
Population based estimation	30 m^3

Comparing the three methods, the primary survey estimates the faecal sludge volume as almost 2 times the volumes estimated by others. It can probably be because of errors in data collection, such as inappropriate data provided by households about the desludging interval and volumes of the containment units. Another reason for this could be the fact the a majority of the households who haven't desludged until the period of this study, their desludging intervals are assumed for the purpose of this calculation as 15 years.

But, the other two values are comparable, though the demand based estimation is currently for the entire city and the population calculation only considers Zone A. Considering the fact that faecal sludge management is a multi dimensional approach to curb leakages across the value chain and it cannot be solved just by setting up a treatment facility, it is imperitive to make a plan which is pragmatic and thoughtful. Compared to the current collection of 14 m^3, setting up a treatment plant for 77 m^3 will render the facility underutilized for a very long time. To be able to collect and convey the sludge from all the containment units as considered in the volumetric approach would require setting effective collection and transportation system as well as stringent monitoring of the faecal sludge disposal, these systems and process would require considerable lead time to be administered within the ULB and till then the excess of capacity is underutilized leading to asset deterioration.

Bhagalpur is growing rapidly and considering the fact that the tentative land available for FSTP construction is on western side, it becomes disincentivising for desludging operators to travel across the city to dispose off at a central location.

However there exists a risk of managing the excess sludge over and above the estimated quantity and its safe disposal as and when the city grows. One option of managing this is by integrating faecal sludge treatment along with the proposed sewage treatment plants in future, this way faecal sludge could be co-treated through appropriate arrangements and the excess capacity could be used for future expansion of the city.

Considering the argument for having many small and decentralized FSTPs and also that excess of capacity might lead to asset deterioration over long time of underutilization, it is recommended to build a treatment plant using quantities estimated through population or demand methods. Adding a buffer of 10% to manage fluctuating loads between days, the proposed volume of faecal sludge estimated for which the treatment facility is to be designed is 32 m^3 per day.

8.2 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. Since the faecal sludge characteristics from a tested sample were unavailable, based on experience, existing engineering knowledge and literature review the faecal sludge characteristics considered for designing the facility are as follows:

Table 16 Characteristics of the Faecal sludge used for design

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)	60000

Faecal sludge characteristics are very variable even within one town or city as they depend on many factors such as the type of sanitation facility from which the sludge is removed, the intervals of emptying, the technique of emptying, etc. Poor knowledge and lack of maintenance services often results in accumulation of organic sludge which reduces effective volume, lower retention times and affects the system performance. However, desludging of pits or septic tanks is perceived as a burden by many home-owners and hence they postpone cleaning until the tanks start overflowing.

In Bhagalpur the toilets in the residential households utilise pour flush facility followed by septic tanks. In Bhagalpur, the local population can be classified as *washers*, therefore water is always used in the toilets. Kitchen wastewater and other grey water do not enter the pits or septic tanks except in cases of a few houses or hotels where the black water and grey water lines are not separated. Cleaning agents used to clean the toilets also end up in the faecal sludge.

In Bhagalpur, the survey claims that the septic tanks and pits are water tight structures. But, water may leache out and also enters during rainy season into the pits or septic tanks. The soil in Bhagalpur is quite permeable. Therefore depending on the season the faecal sludge might be concentrated or diluted.

The storage time in the pit or tank also determines the degree of digestion that would have occurred in the storage unit. In general faecal sludge from public toilets is found to be less digested or stabilized, whereas the sludge from household pits or septic tanks is found to be more stabilized as it has been stored for a longer time. The sludge from pits is less stabilized than sludge from septic tanks as it has been stored for a shorter duration in a pit. The faecal sludge at the bottom of tanks or pits is also found to be more compact and better digested than the sludge at the top.

Mechanical desludging is the most common method of desludging in Bhagalpur. In case of mechanical desludging, if the sludge is too thick, water is mixed with sludge to allow for the pumps to suck out the sludge from the pit or septic tank. In case of septic tanks, the sludge at the bottom is usually not removed. Therefore the contents removed are more liquid like than sludge removed from pits. In general faecal sludge characteristics from on-site sanitation facilities have been reported as listed in Table 17 below.

Faecal sludge is in general much more concentrated than municipal wastewater (10 to100 times higher contents of organic pollutants and suspended solids). Faecal sludge in pits or septic tanks with appreciable levels of organics, nitrogen and pathogens, disposed without proper treatment are a cause of concern on account of the organic carbon (measured as BOD_5), nitrogen, phosphorus and pathogens in the effluent.

To get an understanding of the sludge characteristics from Bhagalpur, composite faecal sludge sample was collected from the outlet of a truck while disposing. Physical appearance, colour and odour were noted (detailed description provided in Annexure 2). Physical, chemical and biological parameters were then analysed in the laboratory at CDD Society.

The characteristics of the faecal sludge from Bhagalpur is enumerated in Table 17.

Table 17: Physical and Chemical Characteristics of faecal sludge from one Sample in Bhagalpur

Sl.no	Parameters	Protocol	Unit	Result - Sample 1
1	Temperature	Thermo Meter	°C	24.0
2	Ph	Multi 340i,		7.12
3	Conductivity	Multi 340i,	mS/cm	3.68
4	Fixed Solids	Gravitemetric	mg/L	30313
5	Alkalinity of CaCO3	Cat No: 1.11109. 0001Aqua Mark	mg/L	20016
6	Total Solids	Gravitemetric	mg/L	59320
7	Volatile Solids	Gravitemetric	mg/L	29007
8	Phosphorus	Spectro quant	mg/L	<100
9	Ammonium (NH4)	Spectro quant	mg/l	<500
10	Total COD	ISO 6060	mg/L	55400
11	BOD	Oxitop	mg/L	-

The characteristics of the sample analysed, show that the faecal sludge has high Total Dissolved Solids content which is why there is a large difference between the COD values and Total Solids Content. This sample also had high pathogen content and has high nutrient content. The faecal sludge would therefore need stabilization and digestion as well as reduction of pathogen content before it can be disposed or reused in farmlands.

8.3 Faecal sludge feeding (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 depends on the capacity and discharge arrangement of 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.

8.4 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 next section.

8.5 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 drying beds. The design and detailing of the treatment modules are carried out taking the aforementioned factors into consideration.

8.6 Odours

The odour problem has been associated with the handling of faecal sludge at the treatment facility. The most characteristic odor of faecal sludge is that of rotten egg which indicates presence of hydrogen sulphide and other gases. The real concern with odors is often not recognized during the design and only becomes apparent after the treatment plant becomes operational. Minimization of odor related issues should be addressed in the design details during the designing stage. The same has been considered for this project by providing proper ventilation for all modules of FSTP. It is also utmost necessary to develop good housekeeping practices in the facility operation

9. Proposed Concept for Implementation of Faecal Sludge Treatment System

In the presence of only pits and septic tanks as a collection and treatment module for faecal sludge management and the absence of further treatment modules, the collected faecal sludge is disposed without treatment. The faecal sludge collected by the trucks is either disposed on farm lands, forest land, or water bodies. Treatment of faecal sludge is required before it can be safely disposed or used.

At present in Bhagalpur there is no faecal sludge treatment facility available. The ground water table in this city is high. Faecal sludge has several characteristics that make it difficult to handle. Faecal sludge cannot be discharged into surface waters or be treated like wastewater because its pollutant concentrations are too high. It cannot be used for direct land disposal or treated like solid waste because its moisture content is too high. It cannot be directly used for crop fertilising because its pathogen content is too high. The first stage of fecal sludge treatment thus mostly involves stabilisation of the sludge and separation of the solid phase and the liquid phase. In this way the liquid part can be treated specifically, usually with wastewater treatment technologies. The solid part can further be treated to enhance its characteristics for reuse applications. Based on the characteristics of the faecal sludge from Bhagalpur, the treatment objectives are listed as

i. Solid Liquid separation
ii. Dewatering
iii. Stabilisation
iv. Reuse in agriculture (If needed)

Sludge treatment involves different treatment steps where available techniques can be combined in various ways depending on the existing constraints and the treatment objectives.

9.1 Options for Faecal Sludge Treatment

Faecal sludge can be treated in a variety of ways and there is no single best option considering the widely varying conditions of urban areas. The criteria for short listing options are based on area requirement, treatment efficiency, simplicity in operation and maintenance, reliability and robustness of treatment modules, odour and public nuisance and cost effectiveness of the system at capex and opex levels.

Table 18: FS Treatment Technologies Shortlisted

Sl. No.	Treatment Stages	Treatment Modules
1.	Pre Treatment	Screen and Grit Chamber
2.	Solid Liquid separation	Feeding Tank Sludge Drying Beds
3.	Solid Stabilization	Biogas Digester Sludge Stabilization Reactor Planted drying beds

5.	Liquid Wastewater Treatment	Settler + Anaerobic Filter Chamber
		Vertical Planted Gravel Filter
6.	Tertiary Treatment	Sand carbon filter and UV treatment

Table 17 below shows comparision between technologies considered. Out of these shortlisted technologies, the optimum combination of treatment technologies selected for Bhagalpur is presented in the next section. The final detailed project report will have this treatment option along with final drawings and estimations for each module.

Table 19: Comparison of Technologies for Treatment of Sludge

Modules	Function	Area	Cost	Operation & Maintenance	Odour	Reuse
Unplanted Drying Bed	Unplanted Drying beds are simple sealed shallow ponds filled with several drainage layers. Sludge is applied on the top and dried by percolation and evaporation	48 m^2/m^3	2.5 lacs/m^3	Trained staff is required for application of sludge, controlling drainage system and desludging Desludging is required every week	Very less chance of odours and flies	Dried sludge cannot be directly used ,it requires further drying which can be done by storage or composting
Planted Drying Bed	Planted Drying beds are simple sealed shallow ponds filled with several drainage layers and Plants. Sludge is applied on the top and dried by percolation and evaporation. The plants maintain the porosity of the soil and enhance the evaporation by transpiration	105 m^2/m^3	5 lacs/m^3	Trained staff is required for application of sludge, controlling drainage system, desludging , maintaining the plant growth Desludging is required 1.5 to 3 years	Odours and flies may be noticeable	Dried sludgec an be used as biosolid in agriculture directly from the PDB
Bio Gas Digester	Wastewater and organic wastes are introduced in an airtight reactor, solids settle to the bottom, where they are decomposed by anaerobic digestion and transformed	1.5 m^2/m^3	50,000/m^3	Trained staff is required for Checking gas-tightness regularly.	Odours may be noticeable	Bio gas can be used for the domestic chores directly from the digester.

	to biogas and fertilising slurry					
Stabilization Reactor	Stabilisation Reactor has three chamber for mixing, stabilization and separation of solid and liquid of the faecal sludge	6.5 m^2/m^3	1.5 lacs/m^3	Trained staff is required to check the regular flow.	No odour is there	No option for reuse

For the final treatment combination it is recommended to use a combination of stabilization reactor along with unplanted drying beds to stabilize sludge. A Stabilization Reactor is preferred over a Biogas digester as most of the HHs have septic tanks and the faecal sludge entering the system will already be partially digested. As a result of this the biogas production in the digester will be very less, around 0.12 m^3/kg as compared to 0.35 m^3/kg for wastewater hence proving that the biogas digester as not an effective treatment solution.

Looking at the above table it is also recommended to opt for unplanted drying beds for dewatering sludge as compared to planted drying beds (PDB) as they take up lesser area and are relatively cheaper and provide a reuse potential. Hence it is proposed to have a stabilisation reactor followed by an unplanted drying bed for the treatment of faecal sludge at Bhagalpur.

9.2 Treatment Concept

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

a) Area
b) Reusabilty
c) Aesthetics
d) Smell and Public Nuisance
e) Cost

As manpower and electricity is limited in Bhagalpur the design has taken into consideration minimum energy and minimum operation and maintenance requirement.

Treatment Stages and Modules adopted:

Table 20: Different Faecal sludge Treatment Stages and Modules

Sl. No	Treatment Stages	Treatment modules
1	Pre-Treatment	Screen Chamber

2	Sludge Stabilisation	Sludge Stabilization Reactor
	Sludge Drying	Sludge Drying Beds
3	Liquid Wastewater Treatment	Integrated Settler and Anaerobic Filter
		Vertical Planted Gravel Filer
4	Tertiary Treatment	Sand carbon filter and UV treatment

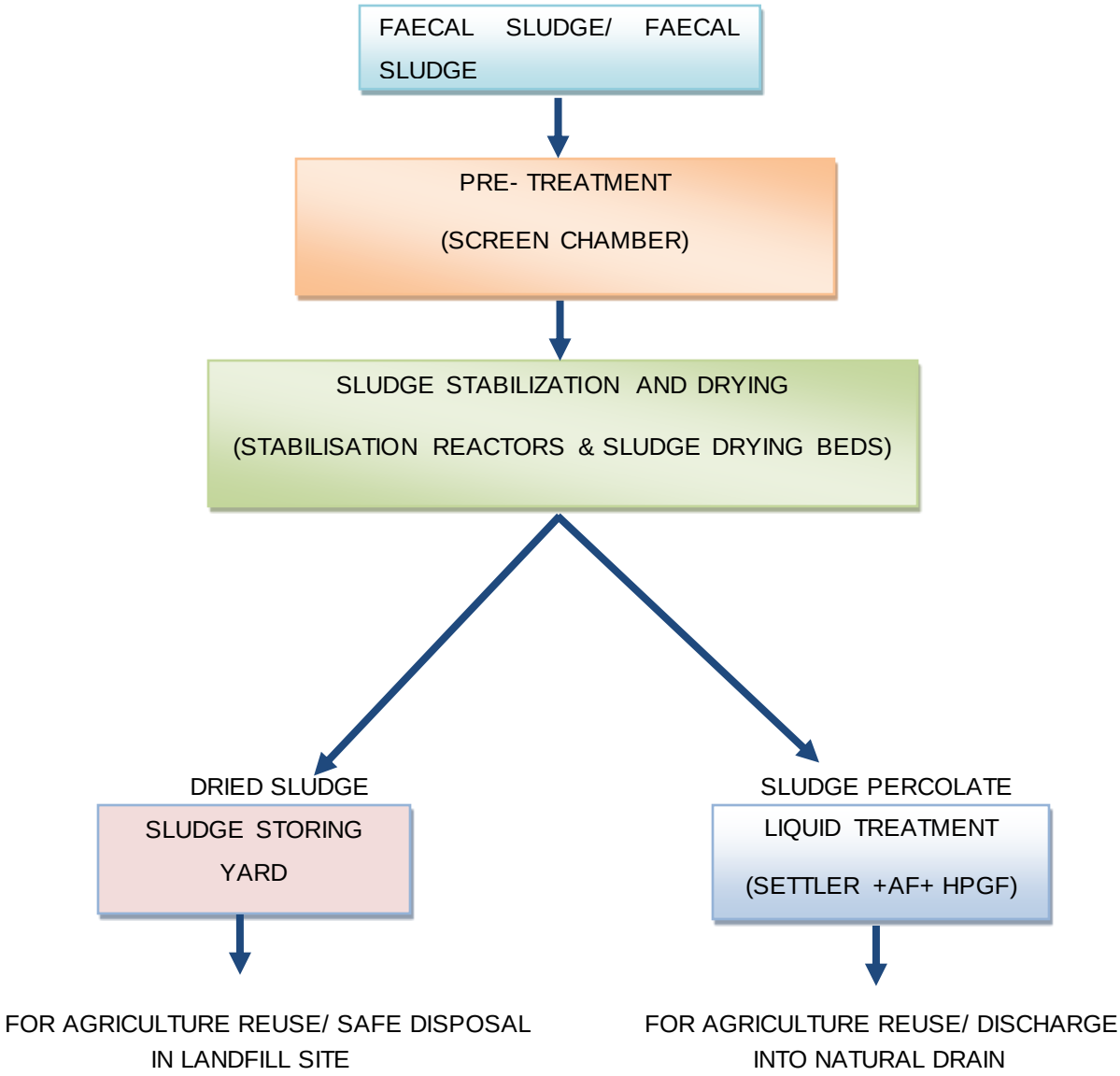
FSTP Concept Proposed For Bhagalpur

This feacal sludge treatment unit is designed for 32 cum capacity. The stabilization and the drying part of the treatment process is divided into 4 modules of 8 m^3 each to ensure effective digestion. The faecal sludge from households of Bhagalpur community would be conveyed 6 days in a week to the treatment unit. The faecal sludge shall first be made to pass through the screening chambers (4 nos) for the retention of coarse materials/ solid waste present in the faecal sludge. The liquid sludge would be conveyed to Stabilistraion Reactor (4 nos) from where they are conveyed to Sludge Drying Beds (SDB) to remove the degradable organic substance and improve its dewatering ability. The solids collected at the bottom of the stabilisation reactor in the form of slurry flows to sludge drying beds by gravity. The sludge drying beds are structures with sloped base for holding graded filter media. The sludge undergoes liquid-solid separation and also drying The dried sludge from the drying beds are removed periodically and transferred to the sludge storage shed located within the premises and the rest of the part which is the liquid percolate or effluent wastewater is conveyed to the collection tank.

The effluent wastewater is then treated in two stages (primary and secondary stage) in DEWATS modules. The primary stages i.e. Settler is mainly meant for Sedimentation of any solids that have entered the modules along with the percolate. The secondary stage i.e. Anaerobic Filter is for the anaerobic degradation of any dissolved and suspended organic matter. The partially treated wastewater from the secondary treatment unit would be conveyed into the vertical planted gravel filter takes place. The treated wastewater from the Vertical planted gravel filter can be reused for agriculture or disposed off safely into a water body.

In future if the quantity of faecal sludge is expected to increase significantly the same system can be replicated in the selected location to accommodate the extra loads. The area available in the selected location for FSTP is **94m x 94m.**

Line Diagram Showing Treatment process.



9.3 Process Flow Description

Pre-treatment

The desludging truck carrying faecal sludge will be directed to a receiving point inside the treatment facility. The faecal sludge received at the treatment facility will be discharged into the screen and grit chamber (four in number) by means of gravity where it undergoes pre-treatment without any exposure to the desludging operator. Large and inorganic solids are trapped in this using a vertical screen and Grit chamber.

The solids collected at this chamber is removed regularly and can be dumped along with municipal solid waste arrangement made by Bhagalpur Nagar Nigam.

Sludge Stabilisation

The liquid sludge (mixture of liquid and solids in slurry form) from the screen and grit chamber is further conveyed to a Sludge Stabilization Reactor (four in number) through gravity for treatment. The main

objective of this treatment system is removal of degradable organic substance and for improving its dewatering ability.

The tank has three chambers, the first chamber of the stabilization tank acts as a homogenization reactor, where the organics are mixed thoroughly. The second chamber provides a digestion zone for anaerobic treatment of organics present in the faecal sludge. The third chamber is a designed for 1 day retention time to collect digested sludge and pump it to further treatment modules.

Sludge drying

The solids collected at the bottom of the stabilisation reactor in the form of slurry are pumped to sludge drying beds. The sludge drying beds are structures with sloped base for holding graded filter media. The sludge undergoes liquid-solid separation and also drying. The percolate from the sludge drying bed is collected and conveyed to the Integrated Settler and AF for further treatment. The dried sludge from the drying beds are removed periodically and transferred to the sludge storage shed located within the premises

Sludge Percolate Treatment

The percolate from the sludge drying bed is subjected to anaerobic treatment in the Settler integrated with AF. It is proposed to provide the settler before the anaerobic treatment to trap any solids getting into the treatment modules. Anaerobic Filter is mainly used for further removal of remaining organic matter in the sludge percolate.

The treated wastewater from the anaerobic reactor is further treated using aerobic treatment process using the Vertical Planted Gravel Filter helps in the reduction of organic matter, removal of odour and color and hygienization.

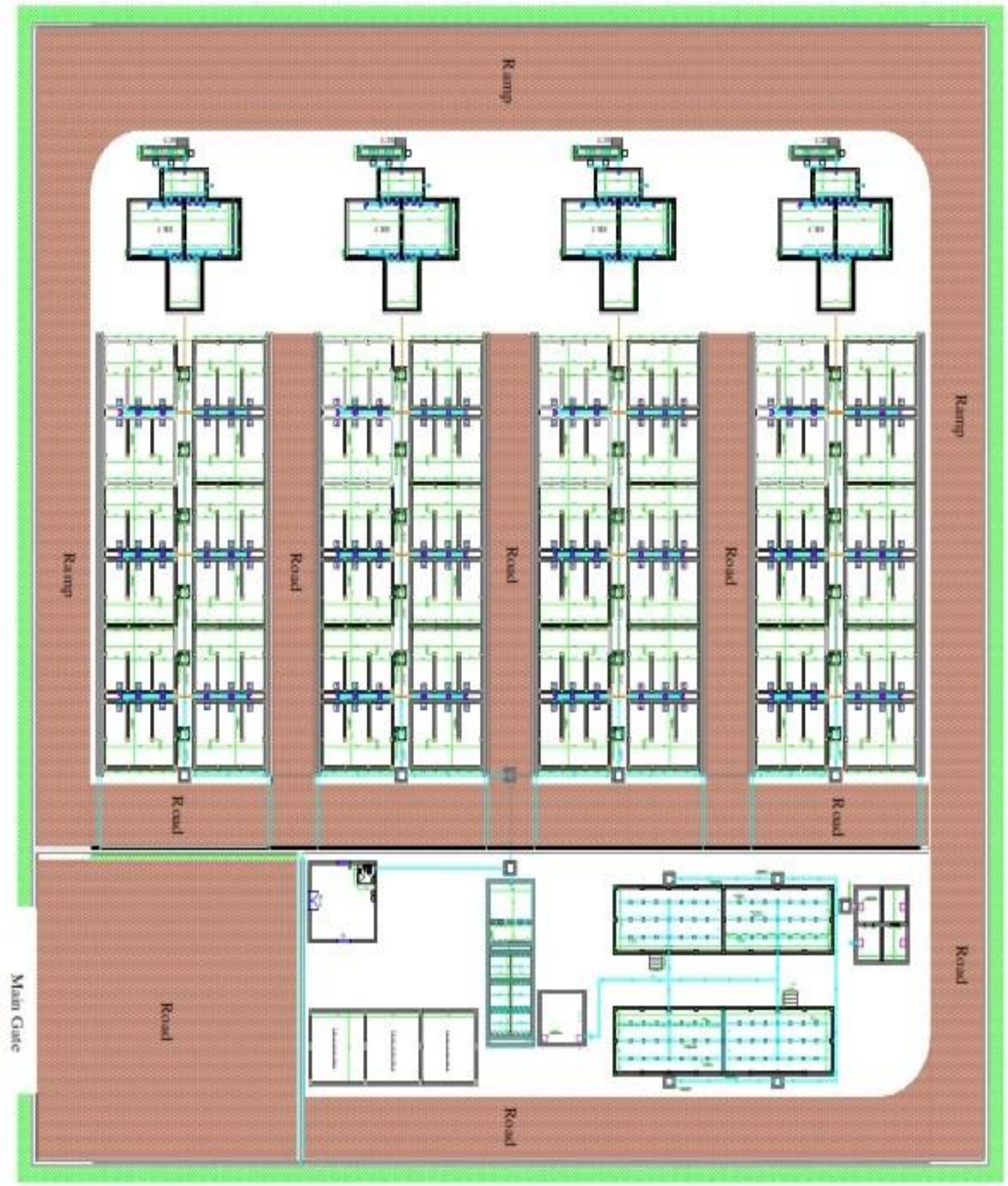
9.4 Area Requirement For Proposed FSTP

Table 21 Design Specifications of Sludge Percolate Treatment Modules

Sl.No	Modules	Nos	Area (sq.m)	Total Area (sq.m)
Total area of the Plant- 8836 sqm- 2.2 acres				
Area of the Modules				
1	Screening Chamber	4	5	20
2	Stabilization Reactor	4	70	280
3	SDB	48	38	1824
4	DEWATS	1	60	60
5	VPGF	2	113	226
6	Collection Tanks- (1)	1	20	20

7	Collection Tanks- (2)	1	32	32
8	Operators Room	1	41	41
9	Sludge Storage House	1	95	95
10	Area of road	1	3150	3150
Total area Excluding road				**2598**
Total area Including Road				**5748**
Total FSTP Area				**8836**

Master Plan


Ramp
Ramp
Ramp
Road
Road
Road
Road
Road
Road
Road
Road
Main Gate

10. End product Specifications

The treatment system has two end products namely:

a) Bio solids
b) Treated Water

Bio gas generated during the anaerobic digestion will be vented out. The specifications of the end products are listed below:

10.1 Bio Solids

Bio solids are dried sludge from drying beds and which are stored for a period of 4-6 months for further stabilization 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 22: 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

Source: Faecal sludge management systems approach for Implementation and Operation, IWA Publications, 2014

10.2 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 also can be discharged into a nearby drain. The characteristics of the treated water are as follows:

Table 23: Treated water characteristics

Parameters	Characteristics of treated water
P^H	6.5-9
Temperature	25 -35 degree
BOD at 5 days mg/L	<30
COD mg/L	<50
Total suspended solids mg/L	<20
Faecal coliform per 100 mL	<100
Total Nitrogen mg/L	< 10

11. Electrical and Mechanical Components of the system

The Faecal Sludge treatment plant uses minimum energy for operations. Electricity use is driven by submersible sludge pump.

- The capacity of pump shall be adequate to meet the requirements of pumping sludge at 7 m head.
- A diesel standby unit (Generator) will be provided to meet the pumping requirements during power failure.
- Street Lights will be provided along the access road within the Treatment plant at intervals.

Table 24 Pump details

Sl No	Pump		Pump details			
	From	Delivery	kW	Discharge	Head	Nos
1	Collection tank 1	V-PGF	2.2	10 cum/hr	4m	1W+1S

Pipes and Fittings

This Section includes the information on all the pipe material and sizes, registers and their sizes, slope provided for conveying the sludge and Supernatant /filtrate. All the valves used in the treatment plant must be Ball valve of the respective diameter

Pipe material and sizes

Table 25 : Pipe material

Sl no	Pipe Material	Diameters used	Remarks
1	HDPE	110mm,160mm	None pressurized. i.e. gravity flow pipes
2	HDPE	110mm, 65mm	All pressurized pipes

Slope

The minimum gradient for the pipes conveying faecal sludge and treated wastewater is provided in the table

Table 26: Slope Details

Sl No	Slope	Remarks
1	1:100	All pipes Conveying wastewater (if not mentioned)
2	1: 50	Bottom slope in sludge drying bed and VPGF
3	1:150	Storm water drain

12. Design Description and Schematic of the Proposed Treatment Modules

12.1 Screen chamber

Figure 12: Screening Chamber

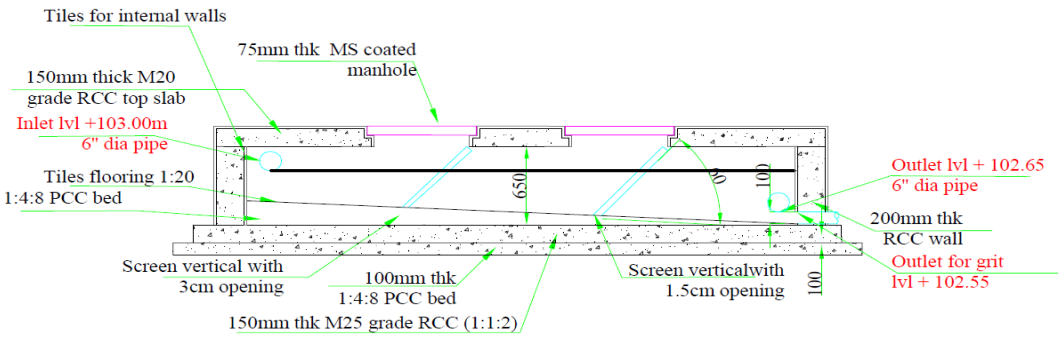
It is a physical method for separation of solid waste and inorganic solids like plastic, cloth, sand, slit etc. from the faecal sludge to prevent clogging of subsequent treatment modules and also enhancing the value of treated end products. Screen chamber uses a series of vertical screens made from mild steel and coated with anti-corrosive elements for this purpose. In the screen chamber proposed for this treatment facility there are 2 vertical screens with the first screen having a 3 cm opening between vertical bars and the second screen has an opening of 1.5 cm. The trash is collected by manually scrapping the screen with a rake or similar arrangement. The collected trash will be stored and disposed along with municipal solid waste collection facility of the Bhagalpur municipality.

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 sludge. 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 27 Specifications for Screen chamber

Parameters	Unit	Values
Area required	m^2	20
Retention time	Seconds	30-60
Number of screen and grit Chambers		4 numbers

Figure 13: Cross section of Screening Chmaber



Screening Chamber

12.2 Stabilisation Reactor

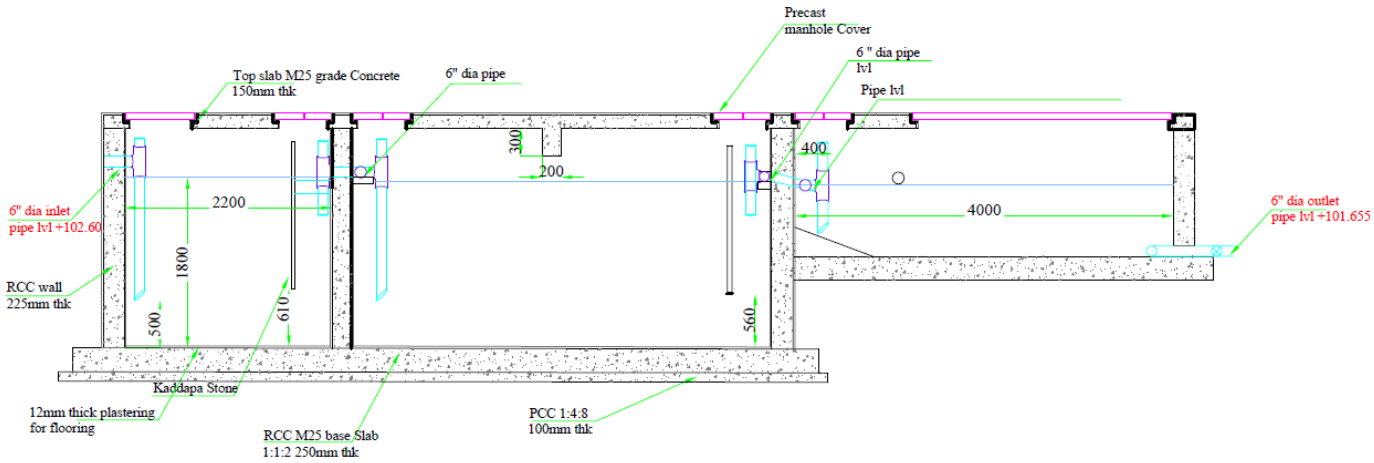
The main objective of the stabilization reactor is to allow the sludge to digest anaerobically which leads to reduced organic load and better dewater-ability. The stabilization reactor has 3 chambers. The first chamber has a retention time of 2 days and assists in homogenization of sludge. During the discharge of sludge from the desludging vehicle high turbulence is created in the chamber with an up-flow velocity of 4-5 m/hr.

The second chamber has a retention time of 10 days and is designed to stabilize the 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.

Table 28 Specifications of Stabilisation Reactor

Parameters	Unit	Values
Treatment capacity	m^3	8
Number of chambers	Nos	3
Sludge Retention time	Days	13
accumulated sludge volume per day	m^3	8

Figure 14: Cross Section of Stabilisation Reactor



12.3 Sludge Drying Beds

The liquid sludge retained at the bottom of the stabilization reactor is pumped into each drying bed. Sludge drying beds are open tanks filled with sand and graded gravel. Each sludge drying bed is designed for 8 cum of faecal sludge. Considering the climate in Bhagalpur, in order to ensure proper drying of the sludge, a maximum of 14 days of drying period is proposed and accordingly the size of each drying bed is calculated.

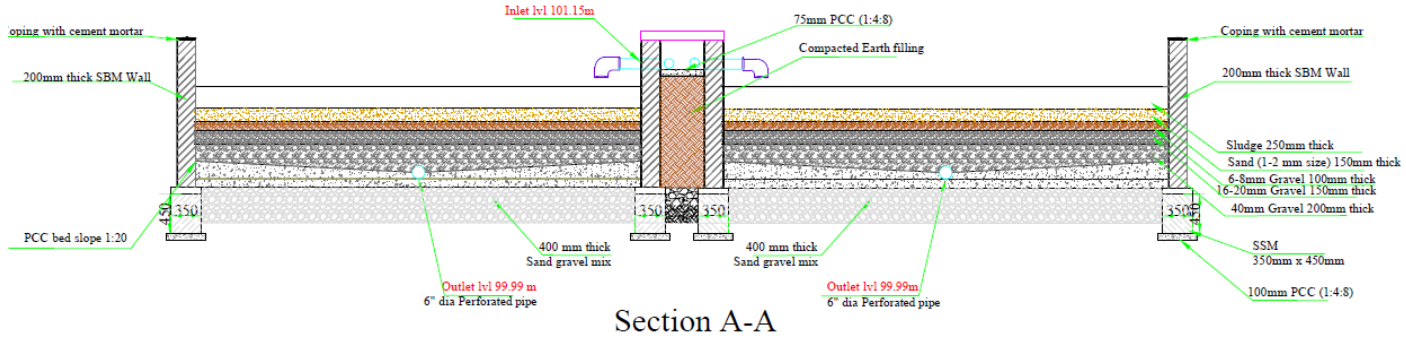
Figure 15: Sludge drying bed

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 majority of these solids with little moisture get retained at the top of the drying beds. The remaining quantity which predominantly liquids known as percolate would be conveyed from the bottom of the bed into the Integrated Settler and Anaerobic Filter for further treatment before being discharged or reused. The sludge drying bed consists of different filter media placed at different depth. A super structure made of transparent sheet is provided in order to prevent rain falling into the drying bed.

Table 29: Specifications of Sludge Drying Bed

Parameters	Unit	Values
Total number of beds	nos	48
Treatment volume of each bed	m^3	8
Area required	m^2	38
Slurry feeding frequency	days	15
Slurry drying period	days	14
BOD outlet (percolate)	mg / L	300 - 600
COD outlet (percolate)	mg / L	1200 - 1500
Dried sludge quantity per bed	Kgs	800 - 1000

Figure 16: Cross Section of Sludge Drying Bed



Section A-A

12.4 Integrated Settler and Anaerobic Filter (AF)

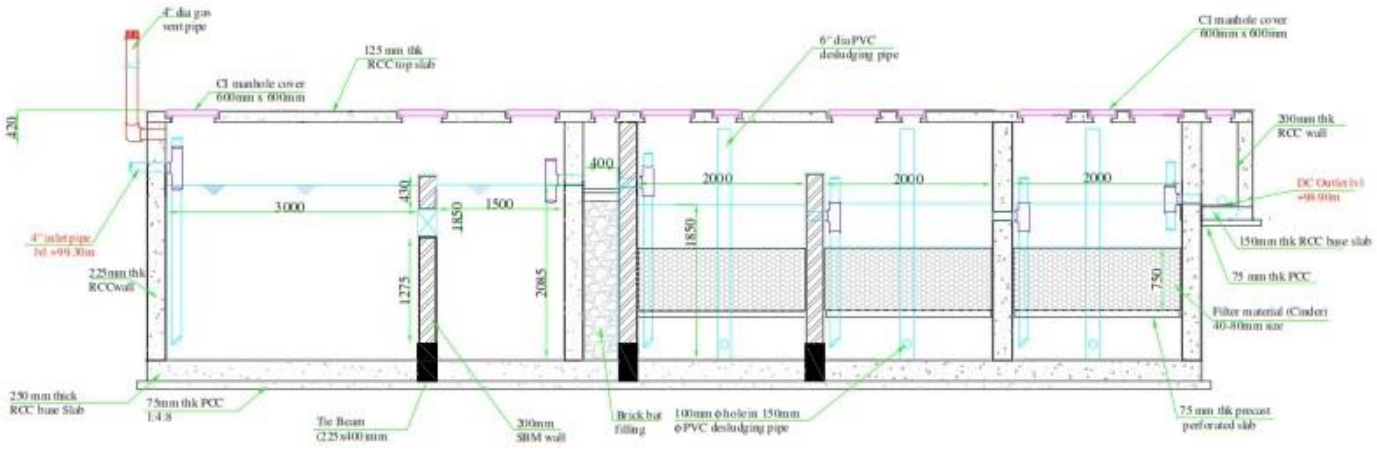
The percolate from the Planted Drying Bed is further subjected to treatment in the Integrated Settler and Anaerobic Filter (AF). Faecal sludge by its own characteristics has very high amount of solids. Although most of the solids will be retained on the top of the planted drying bed, a small percentage of some of the solids may infiltrate the percolate. Therefore, it is proposed to provide a Settler for sedimentation before it enters into the Anaerobic Filters. A settler is a primary treatment technology for wastewater; it is designed to remove suspended solids by sedimentation.

The AF consists of two chambers in series in which the wastewater flows up-stream. Here, the suspended and dissolved solids available in the wastewater undergo anaerobic degradation. The activated sludge settles down at the bottom of each chamber and the influent wastewater is forced to flow through this sludge blanket where anaerobic bacteria make use of the pollutants for their metabolism. As wastewater flows through the filter, particles are trapped and organic matter is degraded by the biomass that is attached to the filter material.

Table 30 Specification of intergrated settler Anaerobic filter (AF)

Parameters	Unit	Values
Faecal sludge quantity	m3	32
Total number of chambers	-	2+3
Hydraulic Retention Time	hrs	36
Area required	m2	60
BOD outlet	mg / L	< 30
COD outlet	mg / L	< 250

Figure 17: Cross section of Integrated Settler and Anaerobic Filter



12.5 Vertical Planted Gravel Filter

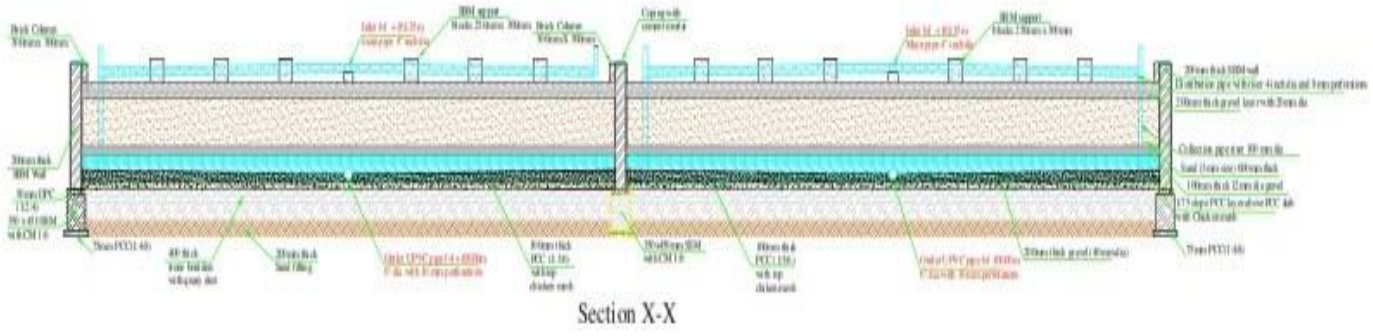
The Planted Gravel Filter is used as an aerobic tertiary treatment unit where the pollutants (mostly nutrients) present in the wastewater are degraded aerobically.

Organic load entering into the VPGF 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. VPGF 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

Table 32: Specifications of Sizes in VPGF

Sl No	Particulars	Values	Unit
1	Supernatant quantity	m3	30
2	Total number of VPGF	Nos.	2
3	Hydraulic Retention Time per PGF	hour	1 hour
4	Area required per PGF	m2	200
5	BOD outlet	mg/l	<10
6	COD outlet	mg/l	<50

Figure 18: Cross section of Vertical Planted Gravel Filter



12.6 Post treatment

The treated water from planted gravel filter is further treated using sand and carbon filter and disinfected using ultra violet radiation. Sand and carbon filters are pressurized vessels containing refined and cleaned sand in one and activated carbon in the other. Sand helps reduce the suspended solids in the treated water to levels as prescribed by the CPCB, while carbon filter reduces any residual odour and colour. These filters are to be backflushed at regular intervals to prevent clogging and ensure efficient working of the system.

Ultra violet radiation is a disinfection method to deactivate the growth and impact of harmful microorganism present in the treated water. Ultra violet radiation is measured in dosages which is intensity multiplied by the exposure time. Recommended dosage for 10 ppm is 27 mWs/cm^2

Table 33: Standard Specification for Sand & Carbon Filter

Parameters	Specifications
Design flow rate	5 m^3 per hour
Design pressure	5 bar

13. Estimated Costing For Implementation

Abstract cost

Table 34: Costs of Proposed Faecal sludge Treatment Modules

Abstract -Costing for the FSTP for Bhagalpur (32cum/day)			
Sl No	Description	Nos	Actual cost in INR
A	**Treatment modules**		
1	Screening chamber	4	₹ 3,35,659
2	Construction of Integrated settler and anaerobic filter	1	₹ 12,24,845
3	Construction of Sludge drying bed	4	₹ 82,17,807
4	Construction of Stabilization Tank	4	₹ 47,41,211
5	Construction of Vertical Planted Gravel Filter	2	₹ 10,25,494
6	Collection tank 1	1	₹ 4,57,226
7	Collection tank 2	1	₹ 5,28,196
8	Sand Carbon Filter	1	₹ 3,00,000
9	UV Disinfection	1	₹ 2,50,000
	Total A		**₹ 1,70,80,437**
B	**Sanitary, Plumbing and collection system**		
1	Plumbing between structures	1	₹ 2,58,647
2	Construction of registers	35	₹ 4,32,231
	Total B		**₹ 6,90,878**
C	**Other civil, mechanical and electrical works**		
1	Rigid Pavement		₹ 31,41,919
2	Sludge storage Room		₹ 11,27,473
3	Operator's room		₹ 4,01,451
4	External wall		₹ 21,60,829
5	Storm water drain		₹ 3,20,429
6	Additional works		₹ 12,01,989
9	Solar Pump System		₹ 5,50,000
10	Retaining wall (including Filling work)		₹ 65,00,000
11	Electrical Work		₹ 8,00,000
	Total C		**₹ 1,62,04,091**
	Contingencies and unforeseen charges (5% of A+B+C)		**₹ 16,98,770**
	Sub Total		**₹ 3,56,74,176**
	Work charge establishment (2%)		**₹ 7,13,483.52**
	Grand Total*		**₹ 3,63,87,659**

14. Operation and Maintenance of Proposed FSTP System

14.1 Operating procedures

It is essential to regularly operate and maintain the FSTP treatment system for its smooth function and improved life span. It is necessary that all sanitation officials/ engineers of Bhagalpur Municipality have a copy of the O&M activities and familiarize themselves with the standard operating procedures. The operator must be familiar with the operating procedures before he starts to operate and maintain the fecal sludge treatment system. It is a must that the operator undergoes a training program dedicated to O&M of FSTP from the service provider.

Below table shows a summary of O&M Steps to be followed. Detailed O&M Activity is given in Annexure 4.

Table 35: O&M activities with responsibility

Activities	Frequency	Details	Responsibility
Daily monitoring procedures	Daily	1. Check for strong odour. The presence of strong odours even after 48 h of sludge disposal is a sign of leakages, or clogging or an overcharged system. 2. Check for colour and turbidity of the treated water that is discharged into the lake 3. The FSTP site must be maintained clean, free from garbage	Operator
Manholes (DEWATS Modules)	Weekly Yearly	1. Manholes should be opened from time to time to check, if there are obstructions preventing the free flow of the water 2. To prevent odours, the air tightness should be assured, by applying silicon or grease on yearly basis or according to the occurrence of odours.	Operator
Check for obstacles in inlet, outlet pipes to the treatment system and gas vents	Weekly	1. Check to see if the inlet/outlet pipes to the treatment system (Planted drying bed, Settler, Anaerobic Baffle filters and Collection tank) and gas vent are clear from any blockage. 2. In case of any blockage, clear the obstacles immediately	Operator
Screening Chamber	Daily/Immediately after feeding of FS Once in 3 to 4 years/when necessary	1. Removing of screened solid waste from faecal sludge and disposing it properly 2. Checking the gaps between screening bars and replacement of screening plate if necessary (If any screening bars are damaged)	Operator Operator
Stabilisation Reactor	Once in 6 months Once in a week Everyday After every desludging	1. Accumulated sludge to be removed from the bottom section of stabilisation reactor 2. Top sections of the stabilisation tank to be inspected for scum accumulation, and cleaned 3. Once the reactor is filled, it is to be opened and sludge let into drying beds 4. All pipes connecting the stabilisation tank and the drying beds to be flushed after every desludging	Operator/Labour Operator Operator Operator
Unplanted Drying Bed	Once in 17 days per bed	1. Sludge to be removed from the drying beds as and when they are dry (~ 50% moisture) and used for co-composting	Operator

	As and when required As and when required	2. Sand layer in the drying bed to be maintained at a minimum of 100 mm thickness. In case excess of sand is lost during sludge removal, fresh sand has to be applied in the beds. 3. Filter materials of the drying beds needs to be cleaned of clogs or replaced when the percolation rate reduces or drying time increases than usual	Operator Operator
Monitoring of sludge level in settler	Monthly	1. Monitor sludge level to predict and perform desludging at the correct time	Operator
Desludging of the settler	Once a year	1. According to the fill up level of the settler compartments, desludging is determined 2. After desludging, the desludging area must be cleaned properly to ensure cleanliness and hygiene	ULB (may use a private desludging service) Operator
Desludging of AF **Filter Materials In AF**	Once a year (or as per O&M calendar) Once a year	1. There should be no thick sludge layer or floating scum layer in AF 2. After desludging, the desludging area must be cleaned properly to ensure cleanliness and hygiene 3. Filter material in AF should be back washed properly	ULB (may use a private desludging service) Operator
Vertical Planted Gravel Filter	Daily Once in 3 years	1. Ensuring of treated wastewater disposal from HPGF 2. Cleaning of Filter Media	Operator Operator
Waste water analysis	Half yearly	1. Regular sampling and analysis of chemical and biological parameters through a certified laboratory should be done (all parameters required by PCB should be tested and recorded) 2. Maintain a log of all test results with the dates to study the efficacy of the treatment system	Local PCB/ULB

Table 36. Roles and responsibility for O&M

Type of key activity	Responsibility
Desludging	ULB (may use a private desludging services)
Treated waste water sample analysis	ULB (should use an authorized lab for testing)
Replacement of SDB filter material	ULB (may use an external agency on a contract basis)
Repair of internal pipe connection system	ULB (may use external agency on a contract basis)
Replacement of manhole covers	ULB(could be facilitated through a tender process)

Table 37 Key issues in O&M of treatment project

Issues	Measures/recommendations
Smooth functioning of FSTP treatment unit	• Hiring of skilled operator for operating the treatment unit • Proper training to the operator from service provider is must

Clogging/damage of Inter connected pipes • Can occur due to solid waste • Can occur due to damaged screening chamber	• Responsible personnel from ULB should ensure that all damaged pipes are replaced with new ones • Operator should ensure that no solid matter enters treatment unit • Replacement of screening plate periodically
Irregular desludging of treatment modules • Sludge may enter into subsequent modules resulting in reduced efficiency of treatment • Clogging of the filter media in AF and SDB	• Responsible personnel from ULB should ensure that regular desludging schedule is followed • The responsible personnel from ULB should ensure that periodic backwashing or replacement of filter materials
Charging activated sludge into AF • Clogging of the filter materials	• At the time of commissioning of the system and transferring sludge from one chamber to another, this must be avoided.
Clogging of filter media in SDB • Can be due to leaves and solid waste entering the SDB	• Sign boards must prominently display this message in local languages and English

Annexure

Annexure 1

Estimation of faecal sludge currently generated

1. Faecal Sludge Generation- Volume of Containment unit method

Number of households	Average Containment volume	Delsudging frequency	Volume desludged per day
3	8.7	< 6 months	0.167
1	9.5	6- 12 months	0.041
13	3.6	1 - 2 years	0.100
7	5.3	2-3 years	0.048
2	6.6	3-4 years	0.012
7	8.5	4-5 years	0.042
7	7.5	5-7 years	0.028
16	8.9	7-10 years	0.054
321	8.0	No information or not desludged	0.549
377			
Total volume desludged per day from 377 survey households			1.04

Therefore

The Total Volume of FS for Residential units per day (m3) = Sum of Volume per day * Total Non-Residential Units / Nonresidential units surveyed

=1.04* 27000 / 377

=**74.5 m3 per day**

Similarly,

Estimates for volume of faecal sludge from non residential units (in m^3) = Estimated FS desludged from surveyed non residential units* total number of non residential units in 11 wards / non residential units surveyed

=0.4* 75[6] / 13

=**2.3 m^3 per day**

2. Faecal Sludge Generation- Population Based Method

Bhagalpur City Population (census 2011) = 4,00,146

[6] As per discussions from the ULB staff. Non residential units include only those with a facility for toilet

Population of Bhagalpur City in 2027 by Graphical Method = 5,20,000

Assume Floating Population of Bhagalpur City 2027 = 27,000

Total Population of Bhagalpur City = 5,47,000

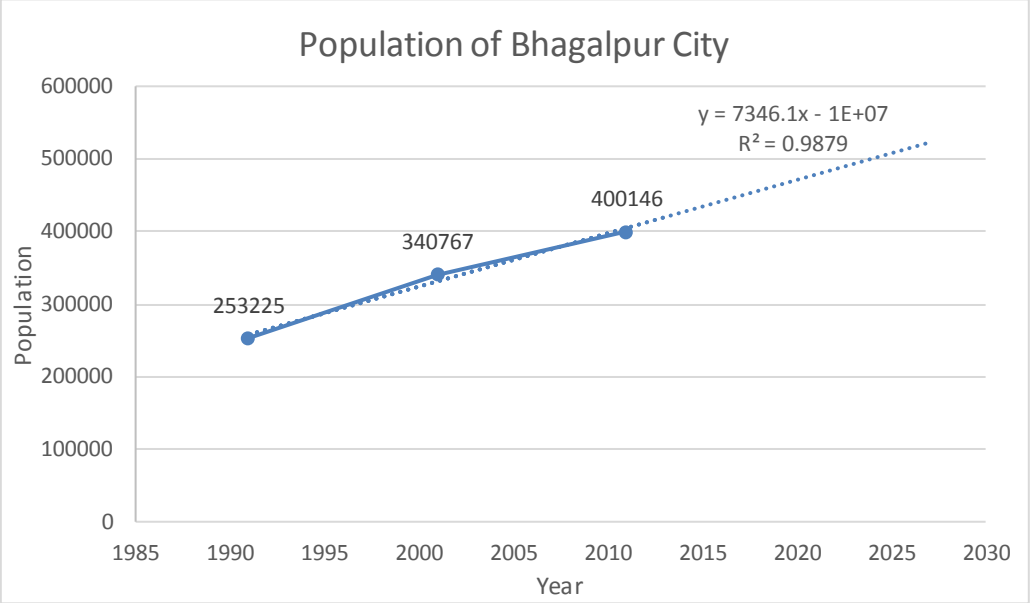
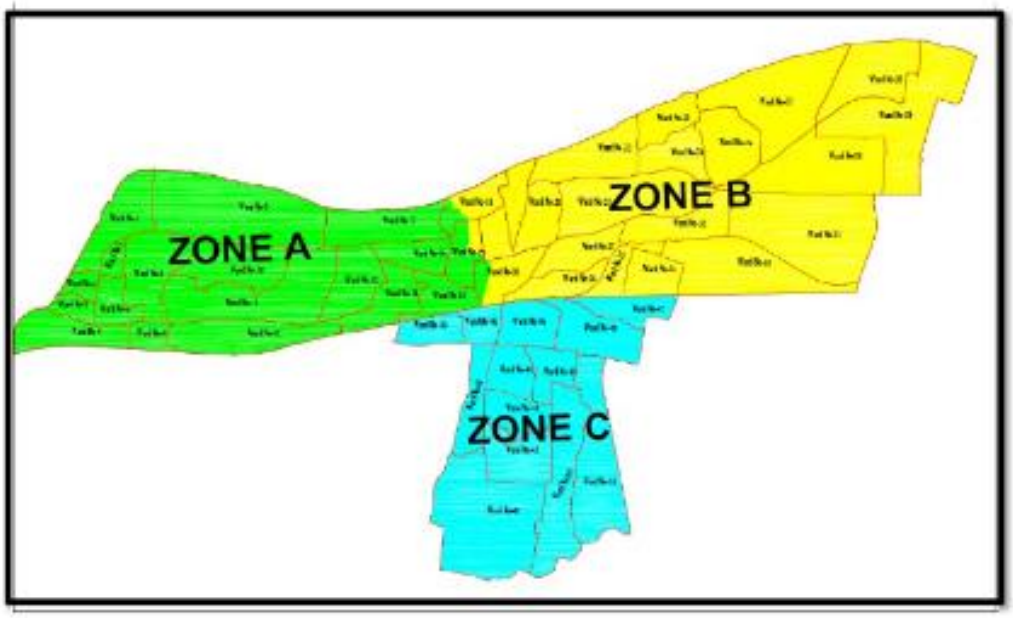


Figure 19: Graph for Bhagalpur Population Growth

Taking Sludge Accumulation Rate = 0.00021m^3/ca/d (CPHEEO Manual)

Therefore faecal sludge generated in a day = 114.87 m^3 /day

Figure 20: Three Major Sewerage Districts of



Therefore Faecal Sludge Generation Zone A (Wards 1 to 13)

Bhagalpur Population zone A (census 2011) = 1,03,727

Assuming the population of zone A increases at the same rate as city.

From graphical method,

City has recorded a growth of 29.95% in 16 years.

The Population of zone 1 in 2027 = 1,03,727* 1.2995 =1,34,793

Lets Assume floating population for 2027 in zone A is 27 % of Population= 7000

Total population of zone A in 2017 = 1,34,793 + 7000 =1,41,793

Faecal Sludge Generated in a day in Zone A = 141793 * .00021

= 30 m^3 /day

3. Faecal Sludge Qunatity based on Collection Method

Desludging capacities of each vehicle per day is

a) 3 m3 vehicle= Capacity of Vehicle * No of trips per day

For Bhagalpur City as per the survey data if we consider there are two vehicles -3.5 m3 and 3.5 m3, then total volume of faecal sludge that can be desludged per day is:

c) 3 m3 vehicle= Capacity of Vehicle * No of trips per day * No of vehicles

= 3.5 * 2 * 1= **7 m3 per day**

d) 4 m3 vehicle= Capacity of Vehicle * No of trips per day * No of vehicles

= 3.5 * 2 * 1= **7 m3 per day**

Annexure 2

Parameters for Laboratory analysis of sample faecal sludge from selected towns.

Parameters to be analyzed for Fecal Sludge

Sl.No	Parameters	Unit	Method
1	COD	mg/l	APHA, AWWA, WEF 2012, 5220 B
2	BOD_5	mg/l	APHA, AWWA, WEF 2012, 5210 B
3	Total Solids	mg/l	APHA, AWWA, WEF 2012, 2540 B
4	Volatile Solids	mg/l	PHA, AWWA, WEF 2012, 2540 E
5	pH		APHA, AWWA, WEF 2012, 4500 HB
6	Total Kjeldahl Nitrogen	mg/l	APHA, AWWA, WEF 2012, 4500 Norg B
7	Total Nitrogen	mg/l	APHA, AWWA, WEF 2012, 4500 Norg
8	Total Phosphates as P	mg/l	APHA, AWWA, WEF 2012, 4500 P F
9	Total Organic Carbon	Mg/l	KMNO1 TITRATION
10	Faecal Coliform	No/100ml	APHA, AWWA, WEF 2012, 9222 A
11	Helminthes Eggs	No/100ml	Wet mount/ Formalin-ether concentration

SLUDGE COLLECTION -ONSITE DATA RECORD

I. Bhagalpur – November 24, 2016

Sample 01- Septic tank consisting of 1 partition wall. The sample was collected at the disposal point i.e. from the cesspool vehicle outlet at the reuse point of an agriculture field.

While collecting the sample a mild odour was observed and the colour of the sample was black. The sample probably has a very high TDS content; hence there is a high difference in COD and TS.

Table 38: Faecal Sludge Sample Parameters

Sl.no	Parameters	Protocol	Unit	Result - Sample 1
1	Temperature	Thermo Meter	°C	24.0
2	Ph	Multi 340i,		7.12
3	Conductivity	Multi 340i,	mS/cm	3.68
4	Fixed Solids	Gravitemetric	mg/L	30313
5	Alkalinity of CaCO3	Cat No: 1.11109. 0001Aqua Mark	mg/L	20016
6	Total Solids	Gravitemetric	mg/L	59320

7	Volatile Solids	Gravitemetric	mg/L	29007
8	Phosphorus	Spectro quant	mg/L	<100
9	Ammonium (NH4)	Spectro quant	mg/l	<500
10	Total COD	ISO 6060	mg/L	55400
11	BOD	Oxitop	mg/L	-

Annexure 3

Technology Options

Screen and Grit chamber

Design and description: It is a physical method for separation of solid waste and inorganic solids like plastic, cloth, sand, slit etc. from the faecal sludge to prevent clogging of subsequent treatment modules and also enhancing the value of treated end products. Screen chamber uses a series of vertical screens made from mild steel and coated with anti-corrosive elements for this purpose. The trash is collected by manually scrapping the screen with a rake or similar arrangement. The collected trash will be stored and disposed along with municipal solid waste collection facility of the Bhagalpur Municipality.

Figure 21: Screen 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 sludge. A horizontal velocity of flow of 15 to 30 cm /sec is used at peak flows. The detention time proposed in the grit chamber is 3 minutes.

Stabilisation Reactor

The main objective of the stabilization reactor is to allow the sludge to digest anaerobically which leads to reduced organic load and better dewater-ability. The stabilization reactor has 3 chambers. The first chamber has a retention time of 2 days and assists in homogenization of sludge. During the discharge of sludge from the desludging vehicle high turbulence is created in the chamber with an up-flow velocity of 4-5 m/hr.The second chamber has a retention time of 10 days and is designed to stabilize the 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

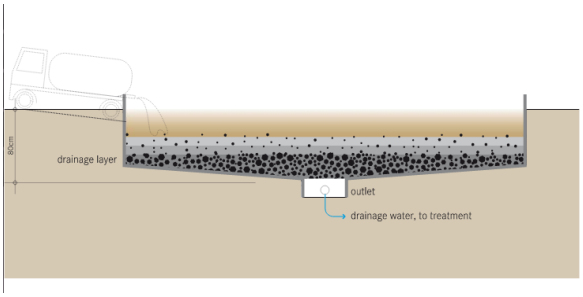
Sludge Drying Beds

Unplanted Drying Bed is a simple, permeable bed filled with several drainage layers. When loaded with sludge, it collects percolated leachate and allows the sludge to dry by percolation and evaporation.

Approximately 50–80% of the sludge volume drains off as liquid or evaporates. This sludge needs additional treatment by composting before it can be safely disposed off or used as a nutrient-rich soil conditioner in agriculture. The percolate, however, still contains pathogens and needs to be further treated.

Design and description: Unplanted drying beds are one of the simplest and oldest techniques to dewater sludge. It includes a simple technique to reduce the volume of the sludge and prepare its reuse as fertiliser. The bottom of the drying bed is lined with perforated pipes to drain away the leachate that percolates through the bed. On top of the pipes are layers of gravel and sand that support the sludge and allow the liquid to infiltrate and collect in the pipe. While the solid fraction remains on the filter surface and is dried by natural evaporation, the liquid percolates. Sludge is applied in layers on top of the gravel beds and is naturally dried. It should not be applied in layers that are too thick as this will deter drying. The final moisture content after 10 to 15 days of drying should be approximately 60%.

Figure 22: Sludge Drying Beds



When the *sludge* is dried, it must be separated from the sand layer and transported for further treatment, *end-use* or final disposal. The leachate that is collected in drainage pipes must be treated further.

Application: Sludge drying beds are a secondary treatment for all kinds of sludge, including faecal sludge from on-site sanitation systems, anaerobic digesters. Sludge drying is an effective way to decrease the volume of sludge, which is especially important when it has to be transported elsewhere for further treatment, *end- use* or disposal. The technology is not effective at stabilizing the *organic* fraction or decreasing the pathogenic content. Further storage or treatment of the dried *sludge* might be required before use in agriculture.

Figure 23: Sludge Drying Beds

Unplanted drying beds are appropriate for small to medium communities with populations up to 100,000 people, but larger ones also exist for huge urban agglomerations. They are best suited for rural and peri-urban areas where there is inexpensive, available space situated far from homes and businesses

Operation and maintenance: Trained staff for operation and maintenance (application of sludge, desludging, control of drainage system and the control of the secondary treatments for percolate or dried sludge) is required to ensure proper functioning. Even though experts are not compulsory for the operation and maintenance, a well-organised community group, which has experience in organic fertiliser use and preparation should be involved.

Dried sludge can be removed after 10 to 15 days, but this depends on the climate conditions. Because some sand is lost with every removal of sludge, the top layer must be replaced when it gets thin. The discharge area must be kept clean and the effluent drains should be regularly flushed.

Supplementary infrastructure and treatment requisite: The leachate collected from the beds needs further treatment.

Advantages:

- After composting dried sludge can be used as fertiliser
- Good dewatering efficiency, especially in dry and hot climates
- Can be built and repaired with locally available materials
- Relatively low capital costs; low operating costs
- Simple operation, only infrequent attention required
- No experts, but trained community required
- No electrical energy is require

Disadvantages:

- Requires a large land area
- Labour intensive removal
- Limited stabilization and pathogen reduction
- Requires expert design and construction supervision
- Leachate requires further treatment

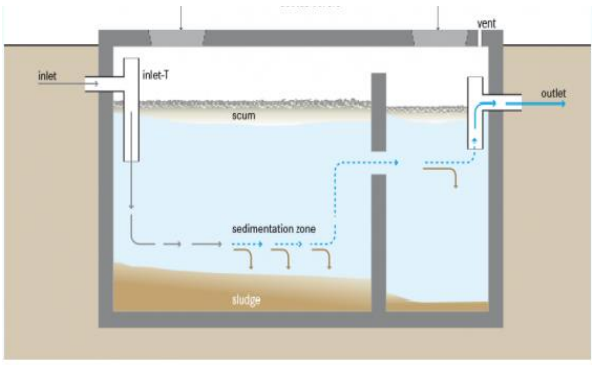
Note: Dried sludge and effluent may require further treatment or storage, depending on the end-use. Sludge can be composted before reuse

Settler

Settling tanks are rectangular tanks, where faecal sludge is discharged into an inlet at the top of one side and the effluent leaves through an outlet on the opposite side, while solids settleto the bottom of the tank, and scum floats on the surface.

Design and description: Settling tanks are watertight chambers which provide primary treatment for wastewater. The liquid flows through the tank and heavy particles (sludge) sink to the bottom, while scum (mostly oil and grease) float at the top. The biochemical oxygen demand (BOD) reduction is about 30 to 50% and TSS reduction is about 40 to 60. The Hydraulic Retention Time is about one day. This technology is not efficient at removing nutrients and pathogens.

Figure 24: Settler



The settling tanks should be appropriately sized and the accumulated sludge and scum must be removed every 2-3 years. At least two settling-thickening tanks should be operated alternately in parallel, in order to allow for sludge removal without overloading the tanks in the process. The loading of FS, and the compaction and removal of the thickened sludge and scum comprise the main phases of an operating cycle. These periods allow for the expected solids-liquid separation and thickening operations.

Application: This technology can be used at household level or cluster level.

Figure 25: Septic Tanks in Ghana

Operation and maintenance: The settling tanks should be regularly checked to ensure it is watertight, and it regular checks for scum and sludge levels should also be done. Sludge needs to be dug out every 1-5 years and discharged properly. Settling tanks need to be vented

Supplementary infrastructure and treatment requisite: Effluent from Settlers need further treatment of wastewater in ABR or any other further treatment of effluent is required for safe disposal or reuse.

Advantages:

- The settler has a low operation cost
- Requires little space due to underground construction
- Can be built and repaired with locally available materials
- Has no real issues with flies or odours if used correctly
- Does not require electrical energy

Disadvantages:

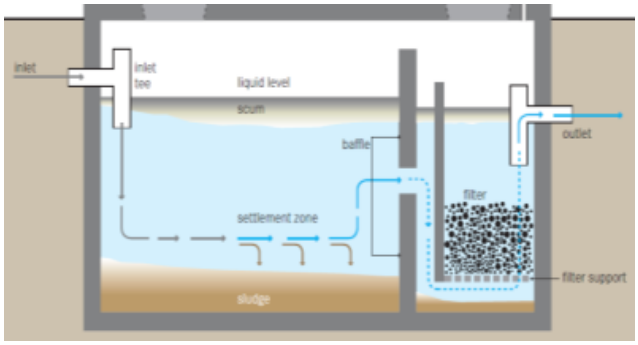
- Settlers have a long start-up phase
- There is a lack of experience in operating with FS
- Lack of empirical data and results on which to base designs for pathogen removal is low
- Effluent and sludge require further treatment

Anaerobic Filter

Anaerobic filters are also known as fixed bed or fixed film reactors. Anaerobic filter tanks are underground or closed watertight tanks with chamber in series with a fixed filter media as shown in Figure - 8.

Design and description: They are generally used as a secondary treatment module for pre-treated wastewater. AF includes the treatment of non settleable and dissolved solids besides treatment through sedimentation and sludge digestion. Filter material such as gravel, rocks, cinder or specially formed plastic pieces provide additional surface area for bacteria to grow. The pre-settled wastewater is made to pass through active bacteria mass growing on the filter media. The larger the surface area of the filter media, the higher the treatment efficiency.

Figure 26: Anaerobic Filter



An important design criterion is equal distribution of wastewater upon the filter area. The baffle walls or pipes ensure the direction of wastewater flow within the tank; it forces the wastewater to flow through the filter media in each chamber. Each of the chambers is designed to take care of the required hydraulic and organic loading. Through intensive contact between wastewater and bacterial biomass, organic matter is digested with short retention times. The HRT of the tank will be 12-36 hrs.

Anaerobic filters are suitable for domestic wastewater with low content of suspended solids. In any case pre-treatment is necessary to prevent clogging. Suspended solids and BOD removal of 85-90% can be achieved.

Application: This technology can be used at household level or cluster level. AF is also used as secondary treatment module in DEWATS, which enhances the overall wastewater treatment efficiency.

Figure 27: Anaerobic filter at Tsunami rehabilitation housing colony, India

Operation and maintenance: The filter media needs to be cleaned by back washing or flushing or may have to be washed and placed back periodically (filter media cleaning every 3-5 years, desludging of tanks every 2-3 years). The baffle pipes needs to be checked for clogging and cleaned regularly. On accumulation of sludge in the AF chambers, desludging needs to be done periodically. Protective gear has to be used and appropriate safety precautions have to be taken while desludging and cleaning filter material.

Supplementary infrastructure and treatment requisite: If AF is used as a standalone system, then pre-treatment of wastewater in septic tank or ABR is necessary and further treatment of effluent is required for safe disposal or reuse.

Advantages:

- Resistant to organic and hydraulic shock loadings
- No electrical energy is required
- Low operating costs
- Long service life
- High reduction of BOD and solids
- Low sludge production; the sludge is stabilized
- Low reduction of nutrients, thus outflow adapted for reuse in agriculture
- Moderate area requirement (can be built underground)

Disadvantages:

- Piped water required to bring the wastes to the treatment unit
- Requires expert design and construction
- Low reduction of pathogens and nutrients
- Effluent and sludge require further treatment and/or appropriate discharge
- Risk of clogging, depending on pre- and primary treatment
- Removing and cleaning the clogged filter media is cumbersome
- Only suitable for low-density housing in areas with low water table and not prone to flooding
- Long start-up time

Vertical Planted Gravel Filter

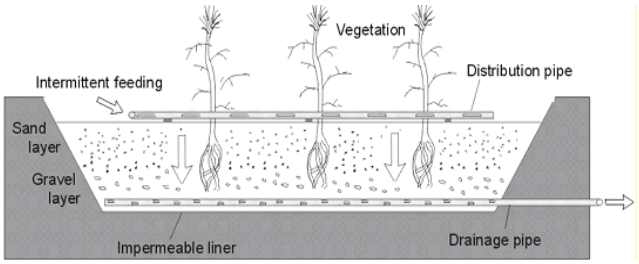
A vertical flow constructed wetland is a planted filter bed for secondary or tertiary treatment of wastewater that is drained at the bottom. Pre-treated Wastewater (e.g. from a septic tank or an Imhoff tank) is poured or dosed onto the surface from above using a mechanical dosing system. The water flows vertically down through the filter matrix to the bottom of the basin where it is collected in a drainage pipe. The water is treated by a combination of biological and physical processes. The filtered water of a well functioning constructed wetland can be used for irrigation, aquaculture, groundwater recharge or is discharged in surface water.

Design description

A typical VF constructed wetland consists of the following components

- Distribution pipe network
- Filter substrate with plantation
- Liner
- Drainage pipe network

Figure 28: Vertical Planted Filter



In vertical filter beds wastewater is intermittently applied (either by pump or self-acting syphon device) onto the surface and then drains vertically down through the filter layers towards a drainage system at the bottom. In some cases, the distribution pipes are covered with gravel to avoid open water puddles. The treatment process is characterized by intermittent short-term loading intervals (4 to 12 doses per day) and long resting periods during which the wastewater percolates through the unsaturated substrate, and the surface dries out. The intermittent batch loading enhances the oxygen transfer and leads to high aerobic degradation activities. Therefore, vertical filters always need pumps or at least siphon pulse loading.

Usually the VF CW is implemented right after a primary treatment using a settler or septic tank. But in this FSTP infrastructure we intend to implement it after settler and anaerobic filter as the source of the FSTP is fecal sludge from pit latrines and septic tanks which are very different from domestic wastewater

Application: Because of the mechanical dosing system, this technology is most appropriate where trained maintenance staff, constant power supply, and spare parts are available. Since vertical flow constructed wetlands are able to nitrify, they can be an appropriate technology in the treatment process for wastewater with high ammonium concentrations. Vertical flow constructed wetlands are best suited to warm climates, but can be designed to tolerate some freezing and periods of low biological activity. Shade from plants and protection from wind mixing is limiting the dissolved oxygen in the water. Constructed wetlands allow for the combination with aquaculture and agriculture (irrigation) what contributes to the optimisation of the local water and nutrient cycle.

Depending on the volume of water, and therefore the size of required land surface, wetlands can be appropriate for small sections of urban areas or more appropriate for peri-urban and rural communities. It is a good treatment technology for communities that already have a primary treatment facility.

Operation and maintenance: Emptying of pre-settled *sludge* should be ensured. Regulare removal of unwanted vegetation and cleaning of inlet/outlet systems should also be done on time.

Supplementary infrastructure and treatment requisite: In order to avoid clogging of filter media, pre-treatment system should be provided before VPGF.

Advantages:

- Utilisation of natural processes
- High reduction of BOD, suspended solids and pathogens
- Ability to nitrify due to good oxygen transfer
- Does not have the mosquito problems of the Free-Water Surface or Horizontal Wetland
- Less clogging than in a Horizontal Subsurface Flow Constructed Wetland
- Requires less space than a Free-Water Surface or Horizontal Flow Wetland
- Low operating cost

Disadvantages:

- Requires expert design and construction, particularly, the dosing system
- Requires more frequent maintenance than a Horizontal Subsurface Flow Constructed Wetland
- A constant source of electrical energy may be required
- Long start-up time to work at full capacity
- Not all parts and materials may be locally available
- High quality filter material is not always available and expensive
- Pre-treatment is required to prevent clogging
- Not very tolerant to cold climates

Annexure 4

Operation and Maintenance

General Rules to be followed in common:

The rules have to be followed in general irrespective of the operation and maintenance guidelines.

General Safety:

Daily:

- Perform normal ground maintenance task.
- Survey the entire site for unsafe conditions.
- Do not leave the open chambers unnoticed.
- Clean and inspect sidewalks.
- Ensure that the manholes are properly fixed in its place.

Monthly:

- Repair or Replace the sign as needed.
- Clean the manholes lid by flushing water
- Lubricate pump and valve bearings.

Annually:

- Paint the direction path and stripe the parking lot.
- Inspect pump conditions annually.
- Repair erosion problem as they occur.
- Observe drainage during major rain.

Operator's Duty:

Daily:

- At the end of the shift, each operator of plant is responsible for cleaning, servicing and inspecting the task to which he is assigned. He will follow the checklist prepared from the manual handbook.
- The operator will certify his completion of the checklist by signing off on a sheet provided for that purpose.

Annually:

- All the chambers in the stabilization tank have to be completely cleaned.

Personal Safety of Operator:

- Going near the plant without the Personal Precautionary equipment's is not advised.
- Smoking is prohibited.

- Littering inside the plant is prohibited
- Always be careful and cautious when in the treatment plant.
- Know the signs.
- Handling the working procedure should be known.
- Training has to be attended.

Regular Operations to be performed in FSTP:

There are few general operations that have to be followed in regular intervals to maintain the efficiency of the plant.

Co-Ordination with the De-sludging operator:

Before the arrival of the truck the driver has to confirm with the plant operator. A time has to be fixed to avoid any confusions for the operator.

1. Maintenance of the Screening Chamber:

1.1 Feeding Of the Screening Chamber:

Before feeding in the sludge into the screening chamber the inlet hose pipe have to be fixed properly into the screening chamber's mouth to avoid any spillage.

When: During the disposal of Faecal Sludge into the Screening Chamber.

Where: From the Cesspool truck to Screening chamber's inlet

How:

1. The operator will fix the hose pipe from the vehicle firmly to the inlet pipe.
2. [Approximately 2 feet of the hosepipe enters the inlet pipe.]
3. The hose pipe is to be held firmly to make sure it does not fall off from the inlet pipe. This is important in order to avoid spillage.
4. The operator will now open the valve at the inlet pipe.
5. The operator has to open the valve at the truck's outlet. To let the Faecal Sludge into the Screening chamber.
6. The FSTP operator needs to observe the sludge flow inside the screening chamber. When the flow becomes negligible, he should stop the feeding process.
7. The operator needs to remove the hose pipe from the inlet pipe with care to avoid spillage of sludge.

Precautions:

- The hose pipe has to be inserted inside the inlet chamber to avoid back flow of the pipe.
- Once the feeding is done the hose pipe has to be flushed with minimal amount of water for cleaning the sludge in the pipe. (The pipe to the chamber should remain connected till the cleaning process).

Tools required: For the Operator: Gloves, Boots, and Mask.

1.2.Cleaning Of Screening Chamber:

This process takes place once the feeding is done into the chamber.

When: After the sludge passes through the bars of the screen chamber this activity has to be performed.

Where: From the screens of the screening chamber.

How:

1. Open the manhole cover of the screening chamber.

2. Collect the solids wastes (condemn, sanitary napkins etc) accumulated at bar screens using a rake and transfer them into a plastic/steel bucket/tray. Care should be taken to prevent spilling of the faecal sludge outside the chamber.

3. Once the accumulated solids have been removed the bar screen has to be cleaned using water and a broom.

4. The collected solids have to be dried by keeping the plastic tray in Sunlight till the end of the day and then weighed on the weighing Machine provided at the FSTP.

5. Close the manhole cover the screening chamber once the task is complete**.**

Precautions: Be very careful while opening and closing of the chamber, it should be immediately closed once the cleaning is done.

Tools Required: For the operator: Gloves, boots, mask, rake broom, bucket.

1.3.Cleaning Of the Grit Chamber:

This process has to take place once in 2 days.

When: If Grit Chamber is getting clogged then this has to be done.

Where: In the chambers surface.

How: The accumulated sludge has to be removed from the surface using a rake.

Precautions: The outlet must remain closed from the chamber to Stabilization tank when the cleaning process is under process.

Tools Required: For the Operator: Gloves, Scrapping blade, mask, bucket.

2.Maintenance of the Stabilization reactor:

2.1 Checking of the 1st Chamber:

The scum has to be removed and this has to be done once a month.

When: Once the sludge enters from the screening chamber to the 1st chamber.

Where: In the 1st chamber of the Stabilization reactor.

How:

1. Open the manhole cover.
2. Check for the presence of scum and solids inside the chambers.
3. Using the fishnet mesh removes the scum out from the chamber
4. Transfer the collected scum in the plastic bin.

Precautions: The manhole has to be closed properly once the process is done.

Tools Required: For the operator: Gloves, Fishnet mesh, Boots, Mask.

2.2Checking the pipelines:

The Pipelines have to be checked for choking. This has to be done twice in a month**.**

When: If there is a problem with the flow of sludge this has to be checked.

Where: The pipes in the Stabilization reactor has to be checked.

How:

1. Remove the cover slab if pipe is provided inside the register chambers.
2. Remove the end cap.
3. Push the iron bars/ L brush into the inlet/outlet pipes to eliminate any grit or solid waste choking the pipe.
4. Simultaneously jet water from the pump into the inlet / outlet pipe.
5. Collect the solid waste from the next chamber using a fishnet sieve and transfer it into the plastic bin.
6. Put end cap/cover and close the manhole cover.

Tools Required: For the operator: Gloves, Mask, L brush.

3. Maintenance of Sludge Drying Bed:

3.1.Removal of the Dried Sludge:

The Sludge is left in the bed to dry for 12 days.

When: Once the sludge is dried completely (when the sand is visible) in the bed then it has to be removed.

Where: In the Sludge drying bed.

How:

1. When the sludge is visibly dry and the underlying sand layer is visible through the cracks in the dried sludge perform the following steps.
2. Remove the dry sludge by hand wearing gloves, tap it to remove excess sand and collect it in a plastic bowl and transfer it to a wheel barrow.
3. Take the wheel barrow towards the Tiller and Trailer next to the back gate of the plant. Dump the dry sludge from wheel barrow into the area dedicated for dry sludge storage.
4. Perform steps 2, 3 and 4 until the bed is completely emptied.

Precautions: During the removal the operator must be careful of not removing it along with the sand.

Tools required: Gum boots, Wheel barrow, Gloves, Mask.

3.2. Cleaning Of inspection pipe of SDB:

This has to be done once in a year.

When: The Sludge Drying bed has to be empty during the process.

Where: In the perforated pipes that are in the sludge drying bed.

How:

1. Perform this task when the SDB is empty.
2. Open the end caps of all the PVC pipes provided for maintenance in the SDB.
3. Pump the water into these pipes.
4. Observe water flowing out from bed at register next to bed.
5. Perform step-3 until water observed at register is clear or pale yellow.
6. If water flowing out in register is not clear or pale yellow after per-forming step 3 and 4 for 5 minutes.
7. Place the end caps back in place after performing the task

Precautions: Do not pump water on the sand layer.

Tools Required: Gum boots, Water hose pipe.

4. Maintenance of the Integrated Chamber and the AF:

4.1. Checking the condition of Filter Material:

1. To allow the required free flow [to avoid clogging] of wastewater through the filter medium**.**

2. To avoid large quantity of sludge accumulation in AF and subsequent treatment module.

3. To retaliate the design treatment efficiency to the effluent quality.

When: At least once in a year Or, in the following cases

1. Excess sludge observed in the chambers of AF or in the subsequent treatment module.

2. There is a backflow in the inlet chamber or no flow of wastewater into the subsequent treatment module.

Where: In the chambers of AF (Anaerobic Filter)

How:

1. Open the manhole covers of AF and outlet chamber.

2. Check if the wastewater has its usual flow or if any flow in the AF chambers and subsequent chambers.

3. Check the quality of the effluent wastewater.

4. If the excess sludge content is found, remove the sludge from the AF chambers (from the bottom) using an appropriate tool

5. Remove the filter material.

6. Clean each of the filter material thoroughly using the water and replace it back in the AF.

Precautions: NA

Tools Required: Trowel, Long shovel, Rake, Bucket, Pan, Wheel barrow, Plastic sheet, Hose pipe, pressure washer.

4.2.Checking of Scum Formation:

To allow the required free flow (to avoid clogging) of wastewater through the treatment system and to avoid grease entering subsequent stages of treatment.

To avoid bad odour in and around the treatment modules.

When: Every month or at least once in three months.

Or, in the following cases

1. Large quantity of scum observed in the chambers of settler and the subsequent chambers.

2. There is a bad odour and overflow from the top of the Settler.

3. There is a backflow at source or in the inlet chamber or no flow of wastewater into the subsequent module.

Where:

1. In the inlet chamber and inlet pipe.

2. At the inlet, outlet pipes and in the chambers of settler.

How:

1.Open the manhole cover of the settler chamber and inspection chambers.

2. Check for the presence of scum in the chamber

3. Check if the wastewater has its usual flow in the settler chamber and subsequent inspection chambers (compare the flow with what was observed in the earlier inspections).

4.Remove the scum from the chamber and from the inlet and outlet pipe of the settler chamber using an appropriate tool.

5. Remove all scum from the inspection chambers and pipes

6.Dispose the scum and other waste into a pit with required safety measures, which is at least 30 feet away from dug or bore wells.

Precautions: The FSTP operator has to wear gloves before performing the task.

Tools Required: Shovel, Stick, Broom

4.3. Checking of Sludge level:

1. To avoid solidification of the sludge.

2. To provide required retention time for the wastewater flowing through the settler.

When: Once in six months.

Or, in the following cases

1. Large quantity of sludge observed in the chambers of settler.

2. When desired treatment efficiency is not observed from the outlet of settler.

3. There is a backflow at source or in the inlet chamber.

Where: In the chambers of SETTLER.

How:

1. Open the manhole covers of the settler and outlet chamber.

2. Check the condition of wastewater flowing to outlet chamber.

3.Check if large quantity of sludge is being carried out.

4. Check the degree of solidification of the accumulated sludge in settler.

5. If the degree of solidification is low, insert desludging pipe into settler and evacuate sludge using desludging equipment.

6. If the sludge has solidified to an extent, mix sludge with water to ensure easy removal using desludging equipment.

7. Dispose the sludge in the sludge treatment unit or dispose locally with appropriate safety measures into a pit.

Precautions: The FSTP operator has to wear gloves before performing the task.

4.4.Vertical Planted Gravel Filter:

Check for Swivel Pipe:

- To ensure efficient usage of filter media for wastewater treatment
- To avoid flooding
- To avoid mosquito growth due to flooding.

When: Once in a month.

Or, in the following cases

1. The water level is observed above the upper surface of the filter material (coarse aggregates)

2. There is dampness observed in the filter material

3. There is no plant growth

4. There is excess mosquito growth.

Where: Swivel pipes (L-pipe) inside the outlet chamber**.**

How:

1. Open the manhole cover of the outlet chamber.

2. Check if the swivel pipe top is at 50cm from the bottom of the outlet chamber.

3. If the swivel pipe top is not at the desired level, lower or raise it until the top of the swivel pipe is 50cm from the bottom of the outlet chamber.

4. If there is no water flow from top of the swivel pipe1, check for leakage at the swivel pipe joint at the bottom.

Precautions: Handle the swivel pipe very carefully.

Tools Required: Measuring tapes, Gloves.

4.5.Weeding Removal:

• To avoid rotting of dead leaf litter in the planted gravel filter.

• To avoid clogging of filter material in the planted gravel filter.

• To maintain the cleanliness and to increase aesthetics near the treatment module

When: Once in a month Or, in the following case

There is excess weed or/and litter.

Where:

• Inside the planted gravel filter

• Around the planted gravel filter

How:

1. Check for presence of dead leaf litter or/and weed inside the planted gravel filter.

2. Check for weed and other litter around the treatment modules

3. If the dead leaf litter or other litter is present, remove it manually or using an appropriate tool.

Precautions: The weeds should be removed by extracting the roots also.

Tools Required: Garden rake, fish net and sieve.

4.6.Trimming of Plants:

- To avoid rotting of dead leaf litter in the planted gravel filter
- To avoid blockages of sunlight.

- To maintain the cleanliness and to increase aesthetics near the treatment modules.
- To prevent blockages organic load by dead leafs.
- To avoid odour.

When: Once in a month Or, in the following case

There is excess growth of plants.

Where: Inside the planted gravel filter

How:

1. Check for presence of dead leaf litter or excess growth of the plants in the planted gravel filter

2. If the dead leaf litter or other litter is present or excess growth of the plants are observes then remove it manually or using an appropriate tool.

Precautions:

- Ensure there are no rodents/snakes/spiders/ants present in the PGF.
- Wear gum boots without fail.

Tools Required:

Garden Scissors, Gum boots, Sickle.

5.Maintenance of the Collection Tank

5.1.Checking of debris in Collection Tank:

- To avoid rotting of dead leaf litter in the collection tank.
- To avoid accumulation of excess debris.
- To avoid stagnation of water.
- To maintain the cleanliness and to increase aesthetics near the treatment modules.

When: Once in 10 days.

Where: Inside the collection tank.

How:

1. Check for presence of dead leaf litter or/and debris inside the collection tank.

2. If the dead leaf litter or debris is present, remove it manually or using an appropriate tool.

3. Clean the collection tank manually.

Precautions: NA

Tools Required: Garden rake, fish net and sieve.

5.2. Cleaning of Inlet and outlet pipes of modules:

When: Once in a week.

Where: Inlet and outlet pipes of Screening Chamber, Stabilization Reactor, Sludge Drying Bed, Anaerobic Filter, Vertical Planted Gravel Filter.

How:

1. Remove the cover slab if pipe is provided inside the register chambers.
2. Remove the end cap.
3. Push the iron bars/ L brush into the inlet/outlet pipes to eliminate any grit or solid waste.
4. Simultaneously force water from the pump into the inlet / outlet pipe. Collect the pushed waste from the next module chamber using a fishnet sieve and transfer it into the plastic bin.
5. Put end cap/cover slab back in place.

Precautions:

Close the main gate when cover slabs are open to avoid anyone entering the plant and coming close to the open manholes.

Tools Required: L-Brush, iron bars, fishnet sieve, Plastic bin.

5.3. Maintenance of Sand Carbon Filter:

When: Daily twice.

Where: In the Collection Tanks 3rd Chamber.

How:

1. Fix two pipe clips on the supporting clamp and position it into the pipework.
2. Connect inlet, outlet drain line with PVC pipe work in valves.
3. Keep the back wash inlet valve open, in case of multiport valve keep the lever position to wash and start the pump to fill the vessel with water. If any leak noticed to be rectified by tightening the union joint & pipe joint by hand only.

Precautions:

Unsupported inlet/outlet line will damage the pipe.

6. Emergency Response:

Introduction:

Improperly treated faecal sludge carries infectious bacteria, viruses, parasites and toxic chemicals. Human contact with this raw or improperly treated sewage can lead to serious health problems. If the FSTP works as designed then there is a reduced risk to public health or environment, however during emergencies, there

can be increased risks. The purpose of this section is to minimize the potentially damaging effects of spills, valve failure, leakages in the system. This section details out the types and levels of emergencies and the specific responses for each. These are usually out of the ordinary event and not part of the day to day operations of the FSTP.

Emergencies that can occur at the FSTP:

- Spillage from the Desludging truck.
- Valve break down.
- Overflow from any treatment module.
- Flooding of SDB
- Solids moving into PGF from AF.

6.1. Spillage from truck:

Cause - Failure of outlet valve of desludging vehicle or wrong operation of outlet valve of the desludging vehicle.

How could this happen?

- Damage of the desludging vehicle's outlet valve during feeding.
- Desludging vehicle outlet valve stuck in open position during feeding
- Spillage from the hose pipe used for feeding of faecal sludge.

Emergency response measures to be taken:

- Desludging vehicle driver should close the outlet valve according to their standard operation.
- To clean the spilled sludge, pour soil over the sludge and leave it for at least 2 hours and then clean it with water.

6.2. Valve break down:

Cause: Failure of valve due to blockages or wrong operation of valves.

How could this happen?

- Failure of valve may happen due to solid waste/debris stuck at the valve's opening.
- Damage to the valve may happen due to wrong operations of the valve by the operator and turning the valves in the wrong direction forcefully.

Emergency response measures to be taken:

- If sludge has spilled near the valve, clean the spilled sludge performing the following steps.
- Pour soil over the sludge. Leave it for at least 2 hours.
- Using the shovel collect all the soil mixed with sludge in a plastic bowl.
- Dispose this sludge in the SDB.
- Repair or replace the valve if necessary.

6.3. Overflow from any treatment module:

Cause: The module outlet or the inlet of the next downstream module is clogged.

How could this happen?

This can happen due to excessive accumulated scum or sludge as well as debris blocking the pipes or modules. Crushed or frozen modules or damage in the pipes connecting the various modules or excessive inflow of water into the module due to flooding may also be responsible for this kind of issue.

Emergency response measures to be taken:

- Stop the flow into the module immediately if any.
- Clear the blockage in the pipes using the iron bar and pumped water. Insert the iron bar in the outlet pipe of the module and force the pumped water
- Check if any debris is stuck in between outlet of the module and inlet of downstream module. If found, try to push it to the next module using the iron bar and collect the debris from the inlet of downstream module. If debris cannot be moved from its place, immediately report it.

- Check for damage/crushing of pipe.

6.4. Flooding of SDB:

Cause: Due to heavy rain in the plant area.

How could this happen?

As SDB are in the point of lowest elevation in the FSTP they are prone to flooding during rainy seasons. The rain water may enter the plant from the back gate and upon rise in level of water above SDB inlet side walls, the water will enter the SDBs. Also if the end caps of inlet pipes of SDB can be point for rain water entry into bed if inlet pipes are not closed with end caps. Leakage of rain water from roof of the beds can be another source of flooding of SDBs.

Emergency response measures to be taken:

- Close the inlet end caps, if they are not closed.
- Call the TMC desludging vehicle to the plant

- Locate the beds filled with water
- Start desludging these beds using the desludging vehicle. Help the desludging vehicle operator in doing the desludging.
- Only desludge the water over the sludge; try not to suck the sludge.

6.5. Solids moving into PGF from AF:

Cause: High level of solids in AF chambers or high rate of flow in AF.

How could this happen?

- Due to high inflow rate into AF from the Screening Chamber solids in the AF chambers may move into the PGF along with the water.
- Not desludging the AF chamber on time as prescribed in the maintenance plan.

Emergency response measure to be taken:

- Stop the wastewater inflow by plugging the inlet.
- Take out all the root bundles and wash them with water and keep them wet by placing them in a bucket filled with water.
- Take out the gravel layer using a straight shovel and wash it with water in a bucket till the sludge gets completely washed off from the filter media surface.
- Place the washed filter materials back in the PGF
- Place the root bundles back in place in a similar fashion as earlier.
- Fill fresh water to the required level (50 cm from bottom of tank) in the PGF.

7. Maintenance of Pumps:

7.1Inspection intervals

Pumps running normal operation should be checked at least once a year, but at least after 3000 operating hours. If the pumped liquid is very muddy or sandy, check the pump at shorter intervals.

The following points should be checked:

• **Power consumption**

See pump nameplate.

• **Oil level and oil condition**

When the pump is new or after replacement of the shaft seal, check the oil level after one week of operation.The oil becomes greyish white like milk if it contains water. This may be the result of a defective shaft seal. The oil should be changed after 3000 operating hours or once a year.

Note: Used oil must be disposed of in accordance with local regulations.

• **Cable entry**

Make sure that the cable entry is watertight and

that the cables are not sharply bent and/or pinched.

• **Pump parts**

Check the impeller, pump housing, etc. for possible wear.

Replace defective parts.

• **Ball bearings**

Check the shaft for noisy or heavy operation

(turn the shaft by hand). Replace defective ball bearings.

A general overhaul of the pump is usually required in case of defective ball bearings or poor motor function.

• **Grinder system/parts**

In case of frequent choke-ups, check the grinder system for visible wear. When worn, the edges of the grinding parts are round and worn. Compare with a new grinder system.

7.2 Cleaning the pump housing

To clean the pump housing, proceed as follows:

Dismantling:

1. Loosen and remove the clamp holding the pump housing and motor together.

2. Lift the motor part out of the pump housing

. The impeller and grinder head are removed together with the motor part.

3. Clean the pump housing and the impeller.

Assembly:

1. Place the motor part with impeller and grinder head in the pump housing.
2. Fit and tighten the clamp.

7.3.Oil change

After 3000 operating hours or once a year, change the oil in the oil chamber as described below. If the shaft seal has been changed, the oil must be changed as well, the shaft seal.

Draining of oil:

When slackening the screws of the oil chamber, note that pressure may have built up in the chamber. Do not remove the screws until the pressure has been fully relieved.

1. Slacken and remove both oil screws to allow all the oil to drain from the chamber.

2. Check the oil for water and impurities. If the shaft seal has been removed, the oil will give a good indication of the condition of the shaft seal.

Note: Used oil must be disposed of in accordance with local regulations.

Oil filling, pump lying down,

1. Place the pump in such a position that it is lying on the stator housing and the discharge flange and that the oil screws are pointing upwards.

2. Fill oil into the oil chamber through the upper hole until it starts running out of the lower hole. The oil level is now correct.

3. Fit both oil screws using the packing material included in then kit.

Oil filling, pump in upright position:

7.4.Fault Detection

Fault	Cause	Remedy
1. Motor does not start. Fuses blow or motor starter trips out immediately. Caution: Do not start again!	a) Supply failure; short-circuit; earth-leakage fault in cable or motor winding. b) Fuses blow due to use of wrong type of fuse. c) Impeller blocked by impurities. d) Level pickup, float switch or electrode out of adjustment or defective.	Have the cable and motor checkeand repaired by a qualified electrician. Install fuses of the correct type. Clean the impeller. Check the level pickups, float switches or electrodes.
2. Pump operates, but motor starter trips out after a short while.	a) Low setting of thermal relay in motor starter. b) Increased current consumption due to large voltage drop. c) Impeller blocked by impurities. Increased current consumption in all three phases. d) Adjustment of impeller clearance incorrect.	Set the relay in accordance with the Specifications on the nameplate. Measure the voltage between 2 motor phase Tolerance: –10%/+6%. Clean the impeller. Readjust the impeller, Clean the impeller.
3. Pump operates at below standard Performance and Power consumption.	a) Impeller blocked by impurities. b) Wrong direction of rotation.	Clean the impeller. Check the direction of rotation ,interchange incoming supply wires.
4.Pump operates, but gives no liquid.	a) Discharge valve closed or blocked. b) Non-return valve blocked. c) Air in pump.	Check the discharge valve and possibly open and/or clean. Clean the non-return valve. Vent the pump.
5. Pump is choked up.	a) Grinder system is worn.	Replace the grinder system.

1. Place the pump on a plane, horizontal surface.

2. Fill oil into the oil chamber through one of the holes until it starts running out of the other hole.

For oil quantity, see section 8.1 Inspection intervals.

3. Fit both oil screws using the packing material included in the kit.

8. OPERATIONAL AND PREVENTIVE MAINTENANCE CHECK LIST

Operational and Preventive Maintenance	Frequency						
	Daily	Weekly	Monthly	3 Mo	6 Mo	Yearly	As Necessary
Check List							
1 Plant Area							
a. Check fence damage	X						
b.Check plant area	X						
2 PRE-TREATMENT							
a. Clean inlet, screens, and properly dispose of trash	X						
b. Check inlet flow	X						
c. Remove and dispose of rags and accumulation from bar screen	X						
d. Check for rock or metal objects in channel	X						
3 Stabilization Reactor							
a. Desludging of stabilization reactor						X	
4 SLUDGE DRYING BED							
a. Check the solidification of the sludge	X						
b. Cleaning of the Vent pipe							X
5 VPGF							
a. Checking of swivel pipes					X		
b. Trimming of Plants							X
c. Removal of weed			X				
6 COLLECTION TANK							
a. Check for debris		X					
b. Cleaning of inlet and outlet pipes of modules			X				
7 VALVES AND GATES							
a. Check to see if set correctly	X						

8	**TERTIARY TREATMENT**							
	a. Replacement of Carbon filter					**X**		
	b. Sand Filter backwash	**X**						
	c. Check for backwash pump	**X**						
9	**PUMPS AND MOTORS**							
	a. Check pumps for clogging or near clogging condition	**X**						
	b. Clean screen at intake of suction piping of pump							**X**
	c. Lubricate pump bearing							**X**
	d. Check pump bearings temperature	**X**						
	e. Drain pump lubricants, wash oil wells and bearings with kerosene				**X**			
	f. Check pump bearings for wear				**X**			
	g. Check motors for heating	**X**						
	h. Replace pump packing							**X**
	i. Check pump shaft sleeves			**X**				
	j. Replace pump shaft sleeves							**X**
	k. Examine pump wearing rings (manufacturer should specify what is excessive)						**X**	
	l. Clean water seal piping						**X**	
	m. Inspect foot valves and check valves					**X**		

Annexure 5

Estimations

Estimated costing for Screening Chamber:

Abstract sheet of Screening Chamber					
Sl.n	**Description**	**Unit**	**Quantity**	**Rate in Rs.**	**Amount in Rs.**
A	**Plain Cement Concrete (P.C.C), 1:4:8**				
	Cement Concrete 1:4:8 (One Cement, Four sand and eight hard broken stone jelly) using 40 mm gauge hard broken granite stone jelly for foundation including dewatering wherever necessary and laid in layers of not more than 15 cm thick, well rammed by using mechanical earth rammer, consolidated and curing etc. complete complying with standard specification and as directed by engineer in charge				
	Total PCC	Cum	0.73	3,598.00	₹ 2,639
B	**Reinforced Cement Concrete (R.C.C), M25**				
	Providing and laying in position specified grade of reinforced cement concrete excluding the cost of centring,shuttering,finishing and reinforcement-All work puto plinth level	cum			
	1:1:2 (1 cement:1 coarse sand:2 graded stone aggregate 20mm nominal size)				
	Total RCC	Cum	3.67	6,035.20	₹ 22,143
C	**Reinforcement**				
	Supplying, fabricating and placing in position TMT bars (Fe 500) for all RCC works as per design given including cost of steel and G.I. binding wire for placing at all depths of excavation, complete complying with standard specification. (Contractor has to make his own arrangements for the supply of steel, binding wire and for bar bending)				
	Thermo-Mechanically Treated bars TMT Fe-500-20mm dia.				
	Total Reinforcement	KG	458.63	53.60	₹ 24,582

D	**Centering/ Shuttering**				
	Supplying and erecting centering for sides and soffits including necessary supports and strutting upto 3.29 M height for plane surfaces as detailed below in all floors with all cross bracings using Mild Steel sheets of size 90 x 60 cm and 10 BG stiffened with welded Mild Steel angle of size 25mm x 25mm x 3 mm for boarding laid over silver oak joists of size 10cm x 6.50 cm spaced at abote 90 cm centre to centre and supported by casurina props of 10cm to 13 cm dia spaced at not more than 75 cm centre to centre etc. complete complying with the standard specificaiton. (Payment for centering shall be given after the concrete is laid)				
	For plane surfaces such as RCC floor slab, roof slab, beams, lintels, bed blocks, landing slab, waist slab, portico slabs and beams, etc.	Sqm	11.03	580.00	₹ 6,399
E	**Solid Block masonry**				
	Providing and constructing precast concrete solid blocks with compresive strength not less than 35 Kg per sqm with cement mortar 1:4 masonry with soild blocks of 40x 20x 20 cms conforming to IS 2185/1965 in super structure including the cost of materials, labour charges, scaffolding, curing complete as per specification	Cum	1.92	4,972.00	₹ 9,531
F	**Tiling of inner surface**				
	Providing and laying Ceramic glazed floor tiles 300x300 mm (thickness to be specified by the manufacturer) of ist quality conforming to IS 15622 of approved make in colours such shades except white , Ivory Grey , Fume Red , Brown , laid on 20 mm thick Cement motar 1:4 (1 cement: 4 coarse sand) including pointing the joints with white cement and matching pigment etc., complete.				
	Total tiling	Sqm	8.38	812.20	₹ 6,806

G	**Plastering with mortar, 1:5**				
	Cement mortar1:5(1 cement:5 coarse sand)12 mm cement plaster of mix: 1:5(1 cement: 5 coarse sand) Cement plaster in course sand.				
	Total plastering	Sqm	20.16	107.40	₹ 2,165
H	**Manhole**				
	Supplying and fixing in position CI manhole covers with CI frames (Heavy duty) of size 60cm x 60cm of best approved quality with necessary welding and painting with one coat of zinc chromite primer and two coats of epoxy painting complete.(As per instruction of Engineer incharge)as per standard specification etc., complete compying with standard specifications				
a	Manhole	Nos	2.00	2,434.00	₹ 4,868
	TOTAL J				
I	**Waste water pipes**				
	Providing and fixing on wall face nplastidsed-PVC (working pressure 4 kgf per sqm) rain water pipes conforming to IS :4985 including jointing with seal ring conforming to IS: 5382 leaving 10 mm gap for thermal expansion.				
a	6 inch dia pipe	RMT	1.50	520.28	₹ 780
J	**Providing and fixing mild steel grill work for screening of wastewater as per drawing including fixtures, necessary welding and painting with one coat of zinc chromite primer and two coats of epoxy painting complete.(As per instruction of site engineer)**				
a	Weld grill with vertical sloping 6 mm thick bar placed at a distance of 3 cms and dimensions of 700 mm x 600 mm	Nos.	1.00	2,000.00	₹ 2,000
b	Weld grill with vertical sloping 6 mm thick bar placed at a distance of 1.5 cms and dimensions of 700 mm x 600 mm	Nos.	1.00	2,000.00	₹ 2,000
	Total for 1 screen chamber				₹ 83,915
	Total for 4 screen chamber				**₹ 3,35,659**

Estimated costing for Stabilisation Recator

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	Abstract sheet of Stabilization Tank				
Sl.n	**Description**	**Unit**	**Quantity**	**Rate in Rs**	**Amount in Rs.**
				rupees	rupees
A	**Plain Cement Concrete (P.C.C), 1:4:8**				
	Cement Concrete 1:4:8 (One Cement, Four sand and eight hard broken stone jelly) using 40 mm gauge hard broken granite stone jelly for foundation including dewatering wherever necessary and laid in layers of not more than 15 cm thick, well rammed by using mechanical earth rammer, consolidated and curing etc. complete complying with standard specification and as directed by engineer in charge				
	Total	Cum	11.56	3,598.00	41,588
B	**Reinforced Cement Concrete (R.C.C), M25**				
	Providing and laying in position specified grade of reinforced cement concrete excluding the cost of centring,shuttering,finishing and reinforcement-All work puto plinth level				
	1:1:2 (1 cement:1 coarse sand:2 graded stone aggregate 20mm nominal size)				
	Total	Cum	59.740	6,035.20	3,60,542
C	**Reinforcement**				
	Supplying, fabricating and placing in position TMT bars (Fe 500) for all RCC works as per design given including cost of steel and G.I. binding wire for placing at all depths of excavation, complete complying with standard specification. (Contractor has to make his own arrangements for the supply of steel, binding wire and for bar bending)				
	Thermo-Mechanically Treated bars TMT Fe-500-20mm dia.				
	TOTAL	KG	7,467.5	53.60	4,00,257
D	**Centering/ Shuttering**				

	Supplying and erecting centering for sides and soffits including necessary supports and strutting upto 3.29 M height for plane surfaces as detailed below in all floors with all cross bracings using Mild Steel sheets of size 90 x 60 cm and 10 BG stiffened with welded Mild Steel angle of size 25mm x 25mm x 3 mm for boarding laid over silver oak joists of size 10cm x 6.50 cm spaced at abote 90 cm centre to centre and supported by casurina props of 10cm to 13 cm dia spaced at not more than 75 cm centre to centre etc. complete complying with the standard specificaiton. (Payment for centering shall be given after the concrete is laid)				
	For plane surfaces such as RCC floor slab, roof slab, beams, lintels, bed blocks, landing slab, waist slab, portico slabs and beams, etc.	Sqm	339.20	580.00	1,96,736
E	**Plastering with mortar, 1:5**				
a	Cement mortar1:5(1 cement:5 coarse sand)12 mm cement plaster of mix: 1:5(1 cement: 5 coarse sand) Cement plaster in course sand.	Sqm	222.53	107.40	23,900
b	20 mm cement plaster of mix ;1:5(1 cement: 5 coarse sand)	Sqm	199.20	150.10	29,900
F	**Manhole**				
	Supplying and fixing in position CI manhole covers with CI frames (Heavy duty) of size 60cm x 60cm of best approved quality with necessary welding and painting with one coat of zinc chromite primer and two coats of epoxy painting complete.(As per instruction of Engineer incharge)as per standard specification etc., complete compying with standard specifications				
	730 x 730	Nos	3	2,407.00	7,221
	1000x 300	Nos	24	3,000.00	72,000
G	**Cuddapah stone**				
	Supplying of polished cuddapah slab of 20/30 mm thickness including laying to correct alignment as direct by engineer in charge. Includes fixing the slab to support structures.				
	Total	Sqm	22.558	360.00	8,121
H	**Waste water pipes**				

	Providing and fixing on wall face nplastidsed-PVC (working pressure 4 kgf per sqm) rain water pipes conforming to IS :4985 including jointing with seal ring conforming to IS: 5382 leaving 10 mm gap for thermal expansion.				
i	6 Inch Dia pipe	RMT	65.5	520.28	34,078
ii	6 inch dia T piece	Nos	25	345.95	8,649
iii	6 inch elbow	Nos	8	288.85	2,311
	Total for 1 Stabilisation tank				**11,85,303**
	Total for 4 Stabilisation tank				**47,41,210.80**

Estimation costing for Sludge Drying Beds

	Astract sheet of Sludge Drying Bed - 12 beds				
Sl.n	Description	Unit	Quantity	Rate in Rs	Amount in Rs
A	**Rate for Earthwork- Excavation**				
a	Earth work in excavation over areas (exceeding 30 cm in depth, 1.5 in width as well as 10 sqm on plan) including disosal of excavated earth, lead upto 50 m and lift upto 1.5 m , disposed earth to be levelled and neatly dressed :				
	Total earthwork excavation - for 12 drying beds	Cum	192.80	336.80	₹ 64,935
b	Removal of excess earth				
	Removal of excess excavated earth from the site and dumping away from the location.	Cum	178.49	31.50	₹ 5,622
c	Refilling filling with excavated earth				
	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20 cm in depth: consolidating each deposited layer by ramming and watering lead	Cum	41.41	74.50	₹ 3,085
d	Supplying and filling with fresh Sand				
	Supplying and filling in foundation, basement, etc with filling sand in layers of not more than 15 cm thick well watered, rammed and consolidated etc. complete complying with standard specification and as directed by the departmental officers.	cum	65.88	1,031.25	₹ 67,939
B	**Rubble solling**				
	Supplying and filling in basement with sand gravel mix in the ratio of 1:1with 0.685 Cu.m of sand and 0.667 Cu.m gravel in layers of not more than 15cm thick, well rammed, watered and consolidated etc., complete complying with standard specification.	Cum	134.24	690.00	₹ 92,628
C	**Plain Cement Concrete (P.C.C), 1:4:8**				
1	Cement Concrete 1:4:8 (One Cement, Four sand and eight hard broken stone jelly) using 40 mm gauge hard broken granite stone jelly for foundation including dewatering wherever necessary and laid in layers of not more than 15 cm thick, well rammed, consolidated and curing etc. complete complying with standard specification and as directed by engineer in charge				
	TOTAL D	Cum	122.03	3,598.00	₹ 4,39,057
D	**Random rubble Stone Masonry**				

	Random rubble Stone Masonry in Cement Mortar 1:6 using best quality of rubble stones for foundation and basement including curing, etc., complete complying with standard specifiction.	Cum	59.98	4,972.00	₹ 2,98,230
E	**Solid Block masonry**				
	Providing and constructing precast concrete solid blocks with compresive strength not less than 35 Kg per sqm with cement mortar 1:4 masonry with soild blocks of 40x 20x 20 cms to super structure including the cost of materials, labour charges, scaffolding, curing complete as per specification				
	Total	Cum	115.20	4,972.00	₹ 5,72,790
F	**Plastering with mortar, 1:5**				
	Cement mortar1:5(1 cement:5 coarse sand)12 mm cement plaster of mix: 1:5(1 cement: 5 coarse sand) Cement plaster in course sand.				
	Total	Sqm	1,188.39	107.40	₹ 1,27,633
G	**Waste water pipes**				
	Providing and fixing on wall face nplastidsed-PVC (working pressure 4 kgf per sqm) rain water pipes conforming to IS :4985 including jointing with seal ring conforming to IS: 5382 leaving 10 mm gap for thermal expansion.				
i	4 inch dia inlet	RMT	69.60	374.90	₹ 26,093
ii	4 inch tee piece	Nos	36.00	333.95	₹ 12,022
iii	4 inch elbow	Nos	36.00	275.80	₹ 9,929
iv	6 inch perforated pipe with 100 perforations at 0,45,90,135 and 180 degree per metre length. Hole dimensions in excess of 10 mm diameter	RMT	78.00	520.28	₹ 40,582
H	**Precast Slabs**				
	Manufacturing, supplying and fixing Precast Reinforced Cement Concrete slabs of following thickness in RCC 1:2:4 (one cement, two sand and four aggregates), using following HBGS jelly including cost of reinforcement steel in position, cost of moulding charges, casting of slab, finishing, curing and fixing in position in all floors etc., complete complying with standard specification and as directed. 75mm thick slab (using 20mm HBGS Jelly)				
	Total	Sqm	41.70	621.75	₹ 25,927
I	**Cuddapah stone**				
	Supplying of polished cuddapah slab of 20/30 mm thickness including laying to correct alignment as direct by engineer in charge. Includes fixing the slab to support structures.	sqm	9.00	360.00	₹ 3,240

J	**Providing and laying of coarse aggregate size as below after washing & sieving to make it free from fines & dust.**				
i	Passing through 50 mm & Retained on 40 mm sieve	Cum	78.00	970.00	₹ 75,660
ii	Passing through 20 mm & Retained on 16 mm sieve	Cum	58.50	1,318.00	₹ 77,103
iii	Passing through 10 mm & Retained on 6 mm sieve	Cum	39.00	789.00	₹ 30,771
iv	Fine sand 1-2 mm	Cum	58.50	1,014.42	₹ 59,344
K	**Dam proof Course**				
	Damp proof course with Cement Mortar 1:4 (One Cement and Four sand) 12mm thick mixed with best approved quality water proofing compound conforming to Indian Standard specification as specified by the departmental officers at 2% by weight of cement used, finishing and curing etc. complete complying with standard specification.	Sqm	133.29	164.00	₹ 21,860
	TOTAL for 12 drying beds				₹ 20,54,452
	Total for 4 sets of 12 beds				**₹ 82,17,807**

Estimated costing for Integrated Settler and AF:

	Abstarct sheet of Integrated Settler and AF				
Sl.n	**Description**	**Unit**	**Quantity**	**Rate in Rs.**	**Amount in Rs.**
A	**Rate for Earthwork- Excavation**				
a	Earth work in excavation over areas (exceeding 30 cm in depth, 1.5 in width as well as 10 sqm on plan) including disosal of excavated earth, lead upto 50 m and lift upto 1.5 m , disposed earth to be levelled and neatly dressed :				
		cum	276.73	336.80	₹ 93,203
b	Removal of excess earth				
	Removal of excess excavated earth from the site and dumping away from the location.	Cum	193.19	31.50	₹ 6,085
c	Refilling with excavated earth				
	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20 cm in depth: consolidating each deposited layer by ramming and watering lead	Cum	183.77	74.50	₹ 13,691
B	**Plain Cement Concrete (P.C.C), 1:4:8**				
1	Cement Concrete 1:4:8 (One Cement, Four sand and eight hard broken stone jelly) using 40 mm gauge hard broken granite stone jelly for foundation including dewatering wherever necessary and laid in layers of not more than 15 cm thick, well rammed, consolidated and curing etc. complete complying with standard specification and as directed by engineer in charge				
	TOTAL C	Cum	5.01	3,598.00	₹ 18,025
C	**Reinforced Cement Concrete (R.C.C), M25**				
1	Providing and laying in position specified grade of reinforced cement concrete excluding the cost of centring, shuttering, finishing and reinforcement-All work puto plinth level				

	1:1:2 (1 cement:1 coarse sand:2 graded stone aggregate 20mm nominal size)				
	Total for RCC	Cum	52.694	6,035.200	₹ 3,18,021
D	**Reinforcement**				
1	Supplying, fabricating and placing in position TMT bars (Fe 500) for all RCC works as per design given including cost of steel and G.I. binding wire for placing at all depths of excavation, complete complying with standard specification. (Contractor has to make his own arrangements for the supply of steel, binding wire and for bar bending)				
	Thermo-Mechanically Treated bars TMT Fe-500-20mm dia.				
	Total for reinforcement	KG	6,701.55	53.6	₹ 3,59,203
E	**Centering/ Shuttering**				
	Supplying and erecting centering for sides and soffits including necessary supports and strutting upto 3.29 M height for plane surfaces as detailed below in all floors with all cross bracings using Mild Steel sheets of size 90 x 60 cm and 10 BG stiffened with welded Mild Steel angle of size 25mm x 25mm x 3 mm for boarding laid over silver oak joists of size 10cm x 6.50 cm spaced at abote 90 cm centre to centre and supported by casurina props of 10cm to 13 cm dia spaced at not more than 75 cm centre to centre etc. complete complying with the standard specificaiton. (Payment for centering shall be given after the concrete is laid)				
	For plane surfaces such as RCC floor slab, roof slab, beams, lintels, bed blocks, landing slab, waist slab, portico slabs and beams, etc.	Sqm	360.63	580.00	₹ 2,09,167
F	**Solid Block masonry**				

	Providing and constructing precast concrete solid blocks with compresive strength not less than 35 Kg per sqm with cement mortar 1:4 masonry with soild blocks of 40x 20x 20 cms to super structure including the cost of materials, labour charges, scaffolding, curing complete as per specification				
	Total	Cum	6.16	4,972.00	₹ 30,625
G	**Plastering with mortar, 1:5**				
a	Cement mortar1:5(1 cement:5 coarse sand)12 mm cement plaster of mix: 1:5(1 cement: 5 coarse sand) Cement plaster in course sand.	Sqm	164.87	107.40	₹ 17,707
b	20 mm cement plaster of mix ;1:5(1 cement: 5 coarse sand)	Sqm	248.106	150.100	₹ 37,241
H	**Manholes**				
	Supplying and fixing in position CI manhole covers with CI frames (Heavy duty) of best approved quality with necessary welding and painting with one coat of zinc chromite primer and two coats of epoxy painting complete.(As per instruction of Engineer incharge)as per standard specification etc., complete compying with standard specifications				
	600 mmx 600 mm	Nos	13	2,407	₹ 31,291
	300 mmx 300 mm	Nos	18	1,200	₹ 21,600
I	**Waste water pipes**				
	Providing and fixing on wall face nplastidsed-PVC (working pressure 4 kgf per sqm) rain water pipes conforming to IS :4985 including jointing with seal ring conforming to IS: 5382 leaving 10 mm gap for thermal expansion.				
i	110 mm dia UPVC pipes fixing	Rmt	19.613	374.90	₹ 7,353
ii	110 mm dia UPVC-Tees fixing	Nos	35	333.95	₹ 11,688
iii	160 mm dia desludging pipe, UPVC, fixing	Rmt	18.126	520.28	₹ 9,431
	0.11m dia, UPVC air vent pipe with vent cowls	Rmt	2	374.90	₹ 750
	110 mm dia Elbow pipe- UPVC	Rmt	1	275.80	₹ 276
J	**Filter material for Anaerobic Filter**				
	Providing and laying Cinders as a Filter Material In AF as per the instruction given by the site engineer in charge.				

	Filter material in AF	Cum	15.80	2,500.00	₹ 39,488
	Total				**12,24,845**

Estimated costing for Vertical Planted Gravel Filter:

Abstract sheet of Vertical Planted Gravel Filter					
Sl.n	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
A	**Rate for Earthwork- Excavation**				
a	Earth work in excavation over areas (exceeding 30 cm in depth, 1.5 in width as well as 10 sqm on plan) including disosal of excavated earth, lead upto 50 m and lift upto 1.5 m , disposed earth to be levelled and neatly dressed :				
	Total earthwork excavation	Cum	81.66	336.80	₹ 27,505
b	Removal of excess earth				
	Removal of excess excavated earth from the site and dumping away from the location.	Cum	78.90	31.50	₹ 2,485
c	Refilling with excavated earth				
	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20 cm in depth: consolidating each deposited layer by ramming and watering lead	Cum	2.76	74.50	₹ 206
B	**Rubble solling**				
	Supplying and filling in basement with sand gravel mix in the ratio of 1:1with 0.685 Cu.m of sand and 0.667 Cu.m gravel in layers of not more than 15cm thick, well rammed, watered and consolidated etc., complete complying with standard specification.	Cum	45.05	690	₹ 31,086
C	**Plain Cement Concrete (P.C.C), 1:4:8**				
	Cement Concrete 1:4:8 (One Cement, Four sand and eight hard broken stone jelly) using 40 mm gauge hard broken granite stone jelly for foundation including dewatering wherever necessary and laid in layers of not more than 15 cm thick, well rammed, consolidated and curing etc. complete complying with standard specification and as directed by engineer in charge				
	TOTAL D	Cum	23.02	3,598.00	₹ 82,814
D	**Random rubble Stone Masonry**				

	Random rubble Stone Masonry in Cement Mortar 1:6 using best quality of rubble stones for foundation and basement including curing, etc., complete complying with standard specifiction.				
	TOTAL	Cum	8.88	4,972.00	₹ 44,135
E	**Solid block masonary**				
	Providing and constructing precast concrete solid blocks with compresive strength not less than 35 Kg per sqm with cement mortar 1:4 masonry with soild blocks of 40x 20x 20 cms to super structure including the cost of materials, labour charges, scaffolding, curing complete as per specification				
	TOTAL	Cum	22.198	4,972.00	₹ 1,10,368
F	**Plastering with mortar, 1:5**				
	Cement mortar1:5(1 cement:5 coarse sand)12 mm cement plaster of mix: 1:5(1 cement: 5 coarse sand) Cement plaster in course sand.				
	TOTAL	Sqm	280.08	107.40	₹ 30,081
G	**uPVC pipes 110mm dia**				
	Providing and fixing on wall face nplastidsed-PVC (working pressure 4 kgf per sqm) rain water pipes conforming to IS :4985 including jointing with seal ring conforming to IS: 5382 leaving 10 mm gap for thermal expansion.				
	Total	Rmt	154.54	374.9	₹ 57,937
H	**Filter material**				
	Providing and constructing vertical/ inclined graded filter media using clean and hard sand and coarse aggregate from approved source in layers including labour work, machinery, laying in slope and compacting etc., as per specification and drawing				
i	Provind and fiulling 20 mm down graded coarse aggregate layer (inlet and outlet)	Cum	20.00	1318.00	₹ 26,360
	Supplying and filling in foundation, basement, etc with filling 3mm coarse sand	Cum	60.00	1014.42	₹ 60,865
ii	Providing and filling 12 mm down graded coarse aggregate layer	Cum	10.00	1229	₹ 12,290
iii	Supplying & Filling 40mm guauge HBGS stone jelly for dispersion trench	Cum	10.00	970.00	₹ 9,700

	Supplying & Filling 40mm guauge HBGS stone jelly for dispersion trench - slope 1:50	cum	9.86	970.00	₹ 9,560
I	**Plants**				
	Providing and planting common reeds or other rhizome with two plant per square metre	nos	140.00	20.000	₹ 2,800
J	**White wash**				
	White washing one coat	Sq.m	63.88	11.85	₹ 757
K	**Dam proof Course**				
	Damp proof course with Cement Mortar 1:4 (One Cement and Four sand) 12mm thick mixed with best approved quality water proofing compound conforming to Indian Standard specification as specified by the departmental officers at 2% by weight of cement used, finishing and curing etc. complete complying with standard specification.	Sqm	23.16	164.00	₹ 3,798
				Total	₹ 5,12,747
	Total for 2 VPGF				**₹ 10,25,494.03**

Estimated costing for Operator Room:

	Abstract sheet of Operator room				
Sl.n	**Description**	**Unit**	**Quantity**	**Rate in Rs**	**Amount in Rs**
A	**Rate for Earthwork- Excavation**				
a	Earth work in excavation over areas (exceeding 30 cm in depth, 1.5 in width as well as 10 sqm on plan) including disosal of excavated earth, lead upto 50 m and lift upto 1.5 m , disposed earth to be levelled and neatly dressed :				
	Total	cum	76.642	336.80	25813
b	Removal of excess earth				
	Removal of excess excavated earth from the site and dumping it 1km away from the location.	Cum	73.142	31.50	2304
c	Refilling with excavated earth				
	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20 cm in depth: consolidating each deposited layer by ramming and watering lead				
	Excavated quantity	Cum	3.500	19.50	68
B	**Rubble solling**				
	Supplying and filling in basement with sand gravel mix in the ratio of 1:1with 0.685 Cu.m of sand and 0.667 Cu.m gravel in layers of not more than 15cm thick, well rammed, watered and consolidated etc., complete complying with standard specification.	Cum	16.800	690.00	11592
C	**Plain Cement Concrete (P.C.C), 1:4:8**				

	Cement Concrete 1:4:8 (One Cement, Four sand and eight hard broken stone jelly) using 40 mm gauge hard broken granite stone jelly for foundation including dewatering wherever necessary and laid in layers of not more than 15 cm thick, well rammed, consolidated and curing etc. complete complying with standard specification and as directed by engineer in charge				
	Total PCC	Cum	5.427	3,598.00	19526
D	**Reinforced Cement Concrete (R.C.C), M25**				
	Providing and laying in position specified grade of reinforced cement concrete excluding the cost of centring, shuttering, finishing and reinforcement-All work puto plinth level	cum			
	1:1:2 (1 cement:1 coarse sand:2 graded stone aggregate 20mm nominal size)				
	Total RCC	Cum	17.184	6,035.20	103709
E	**Reinforcement**				
	Supplying, fabricating and placing in position TMT bars (Fe 500) for all RCC works as per design given including cost of steel and G.I. binding wire for placing at all depths of excavation, complete complying with standard specification. (Contractor has to make his own arrangements for the supply of steel, binding wire and for bar bending)				
	Thermo-Mechanically Treated bars TMT Fe-500-20mm dia.				
	Total Reinforcement	KG	2,148.00	53.60	115133
F	**Centering/ Shuttering**				

	Supplying and erecting centering for sides and soffits including necessary supports and strutting upto 3.29 M height for plane surfaces as detailed below in all floors with all cross bracings using Mild Steel sheets of size 90 x 60 cm and 10 BG stiffened with welded Mild Steel angle of size 25mm x 25mm x 3 mm for boarding laid over silver oak joists of size 10cm x 6.50 cm spaced at abote 90 cm centre to centre and supported by casurina props of 10cm to 13 cm dia spaced at not more than 75 cm centre to centre etc. complete complying with the standard specificaiton. (Payment for centering shall be given after the concrete is laid)				
	For plane surfaces such as RCC floor slab, roof slab, beams, lintels, bed blocks, landing slab, waist slab, portico slabs and beams, etc.	Sqm	42.8	580.00	24801
G	**Solid Block masonry**				
	Providing and constructing precast concrete solid blocks with compresive strength not less than 35 Kg per sqm with cement mortar 1:4 masonry with soild blocks of 40x 20x 20 cms to super structure including the cost of materials, labour charges, scaffolding, curing complete as per specification				
	Total	Cum	12.6	4,972.00	62673
H	**Plastering with mortar, 1:5**				
	Cement mortar1:5(1 cement:5 coarse sand)12 mm cement plaster of mix: 1:5(1 cement: 5 coarse sand) Cement plaster in course sand.				
	Total plastering	Sqm	176.116	107.40	18915
I	**White wash**				
	White washing one coat with freshly burnt white shell lime in all floors including cost of lime, blue powder, fevicol type gum, brushes, scaffolding charges, etc., complete complying with standard specification and as directed by the engineer in charge	Sqm	140.1	11.80	1653
J	**Sanitary fittings**				

a	Supplying and fixing in position best quality cuddapah sink of following sizes including cost of 32mm dia CP waste coupling, 32mm dia PVC waste pipe with rubber plug and chain, 15mm dia brass nipple including fixing the sink in position and testing for leakages etc., complete complying with standard specifications excluding CI brackets. [The sink and specials should be got approved by the Engineer before use on works]	Nos.	2.0	1,527.00	3054
b	Providing and fixing water closet squatting pan (Indian type W.C.pan) with 100 mm sand cast Iron P or S trap, 10 litre low fixtures complete, including cutting and making good the walls andlevel white P.V.C. flushing cistern, including flush pipe, with manually controlled device (handle lever) conforming to IS : 7231, with all fittings and floors wherever required : White Vitreous china Orissa pattern W.C. pan of size 580x440 mm with integral type foot rests	Nos.	1	3049.3	3049.3
K	**Door and Windows**				
	Manufacture and installation of MS steel door with handle including all hinges and frames (Refer Drawing)	Nos.	2.0	2,900.00	5800
	Manufacture and installation of MS steel window with handle including all hinges and frames (Refer Drawing)	Nos.	1.0	1,800.00	1800
L	**Waste water pipes**				
	Providing and fixing on wall face nplastidsed-PVC (working pressure 4 kgf per sqm) rain water pipes conforming to IS :4985 including jointing with seal ring conforming to IS: 5382 leaving 10 mm gap for thermal expansion.				
a	6 inch dia pipe	RMT	3.00	520.28	1561
	Total				**₹ 4,01,451**

Estimated costing for Collection Tank 1:

Abstract sheet of Collection Tank 1					
Sl.n	**Description**	**Unit**	**Quantity**	**Rate in Rs.**	**Amount in Rs.**
A	**Rate for Earthwork- Excavation**				
a	Earth work in excavation over areas (exceeding 30 cm in depth, 1.5 in width as well as 10 sqm on plan) including disosal of excavated earth, lead upto 50 m and lift upto 1.5 m , disposed earth to be levelled and neatly dressed :				
	Total	Cum	120.02	336.80	₹ 40,421
b	Removal of excess earth				
	Removal of excess excavated earth from the site and dumping away from the location.	Cum	81.48	31.50	₹ 2,567
c	Refilling with excavated earth				
	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20 cm in depth: consolidating each deposited layer by ramming and watering lead	Cum	88.89	74.50	₹ 6,622
B	**Plain Cement Concrete (P.C.C), 1:4:8**				
	Cement Concrete 1:4:8 (One Cement, Four sand and eight hard broken stone jelly) using 40 mm gauge hard broken granite stone jelly for foundation including dewatering wherever necessary and laid in layers of not more than 15 cm thick, well rammed, consolidated and curing etc. complete complying with standard specification and as directed by engineer in charge				
	TOTAL D	Cum	2.46	3,598.00	₹ 8,847
C	**Reinforced Cement Concrete (R.C.C), M25**				
	Providing and laying in position specified grade of reinforced cement concrete excluding the cost of centring, shuttering, finishing and reinforcement- All work puto plinth level				
	1:1:2 (1 cement:1 coarse sand:2 graded stone aggregate 20mm nominal size)				
	TOTAL	Cum	22.34	6,035.20	₹ 1,34,813
D	**Reinforcement**				

	Supplying, fabricating and placing in position TMT bars (Fe 500) for all RCC works as per design given including cost of steel and G.I. binding wire for placing at all depths of excavation, complete complying with standard specification. (Contractor has to make his own arrangements for the supply of steel, binding wire and for bar bending)				
	Thermo-Mechanically Treated bars TMT Fe-500-20mm dia.				
	Total Reinforcement	KG	2,792.23	53.6	₹ 1,49,663
E	**Centering/ Shuttering**				
	Supplying and erecting centering for sides and soffits including necessary supports and strutting upto 3.29 M height for plane surfaces as detailed below in all floors with all cross bracings using Mild Steel sheets of size 90 x 60 cm and 10 BG stiffened with welded Mild Steel angle of size 25mm x 25mm x 3 mm for boarding laid over silver oak joists of size 10cm x 6.50 cm spaced at abote 90 cm centre to centre and supported by casurina props of 10cm to 13 cm dia spaced at not more than 75 cm centre to centre etc. complete complying with the standard specificaiton. (Payment for centering shall be given after the concrete is laid)				
	For plane surfaces such as RCC floor slab, roof slab, beams, lintels, bed blocks, landing slab, waist slab, portico slabs and beams, etc.	Sqm	149.89	580.00	₹ 86,933
F	**Plastering with mortar, 1:5**				
a	Cement mortar1:5(1 cement:5 coarse sand)12 mm cement plaster of mix: 1:5(1 cement: 5 coarse sand) Cement plaster in course sand.	Sqm	84.60	107.40	₹ 9,086
b	20 mm cement plaster of mix ;1:5(1 cement: 5 coarse sand)	Sqm	73.12	150.100	₹ 10,975
G	**Manhole**				

	Supplying and fixing in position CI manhole covers with CI frames (Heavy duty) of size 60cm x 60cm of best approved quality with necessary welding and painting with one coat of zinc chromite primer and two coats of epoxy painting complete.(As per instruction of Engineer incharge)as per standard specification etc., complete compying with standard specifications	Nos	2.00	2,407.00	₹	4,814
H	**Waste water pipes**					
	Providing and fixing on wall face nplastidsed-PVC (working pressure 4 kgf per sqm) rain water pipes conforming to IS :4985 including jointing with seal ring conforming to IS: 5382 leaving 10 mm gap for thermal expansion.					
i	110 mm dia UPVC pipes fixing	Rmt	5.00	374.90	₹	1,875
ii	110 mm dia UPVC-Tees	Nos	1.00	333.95	₹	334
	110 mm dia Elbow pipe - UPVC	Nos	1.00	275.80	₹	276
	Total				**₹**	**4,57,226**

Estimated costing for Collection Tank 2:

Abstract sheet of Collection Tank 2					
Sl.n	**Description**	**Unit**	**Quantity**	**Rate in Rs.**	**Amount in Rs.**
A	**Rate for Earthwork- Excavation**				
a	Earth work in excavation over areas (exceeding 30 cm in depth, 1.5 in width as well as 10 sqm on plan) including disosal of excavated earth, lead upto 50 m and lift upto 1.5 m , disposed earth to be levelled and neatly dressed :				
	Total	Cum	100.60	336.80	₹ 33,883
b	Removal of excess earth				
	Removal of excess excavated earth from the site and dumping it 1km away from the location.	Cum	73.01	31.50	₹ 2,300
c	Refilling with excavated earth				
	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20 cm in depth: consolidating each deposited layer by ramming and watering lead	Cum	38.74	19.50	₹ 755
B	**Plain Cement Concrete (P.C.C), 1:4:8**				
	Cement Concrete 1:4:8 (One Cement, Four sand and eight hard broken stone jelly) using 40 mm gauge hard broken granite stone jelly for foundation including dewatering wherever necessary and laid in layers of not more than 15 cm thick, well rammed, consolidated and curing etc. complete complying with standard specification and as directed by engineer in charge				
	TOTAL D	Cum	3.18	3,598.00	₹ 11,448
C	**Reinforced Cement Concrete (R.C.C), M25**				
	Providing and laying in position specified grade of reinforced cement concrete excluding the cost of centring, shuttering, finishing and reinforcement-All work puto plinth level				
	1:1:2 (1 cement:1 coarse sand:2 graded stone aggregate 20mm nominal size)				
	TOTAL	Cum	25.44	6,035.20	₹ 1,53,538
D	**Reinforcement**				

	Supplying, fabricating and placing in position TMT bars (Fe 500) for all RCC works as per design given including cost of steel and G.I. binding wire for placing at all depths of excavation, complete complying with standard specification. (Contractor has to make his own arrangements for the supply of steel, binding wire and for bar bending)				
	Thermo-Mechanically Treated bars TMT Fe-500-20mm dia.				
	Total Reinforcement	KG	3,180.05	53.60	₹ 1,70,451
E	**Centering/ Shuttering**				
	Supplying and erecting centering for sides and soffits including necessary supports and strutting upto 3.29 M height for plane surfaces as detailed below in all floors with all cross bracings using Mild Steel sheets of size 90 x 60 cm and 10 BG stiffened with welded Mild Steel angle of size 25mm x 25mm x 3 mm for boarding laid over silver oak joists of size 10cm x 6.50 cm spaced at abote 90 cm centre to centre and supported by casurina props of 10cm to 13 cm dia spaced at not more than 75 cm centre to centre etc. complete complying with the standard specificaiton. (Payment for centering shall be given after the concrete is laid)				
	For plane surfaces such as RCC floor slab, roof slab, beams, lintels, bed blocks, landing slab, waist slab, portico slabs and beams, etc.	Sqm	162.27	580.00	₹ 94,119
F	**Solid Block masonry**				
	Providing and constructing precast concrete solid blocks with compresive strength not less than 35 Kg per sqm with cement mortar 1:4 masonry with soild blocks of 40x 20x 20 cms to super structure including the cost of materials, labour charges, scaffolding, curing complete as per specification	Cum	4.11	4,972.00	₹ 20,440
G	**Plastering with mortar, 1:5**				
a	Cement mortar1:5(1 cement:5 coarse sand)12 mm cement plaster of mix: 1:5(1 cement: 5 coarse sand) Cement plaster in course sand.	Sqm	92.82	107.40	₹ 9,969

b	20 mm cement plaster of mix ;1:5(1 cement: 5 coarse sand)	Sqm	130.28	150.100	₹	19,555
H	**Manhole**					
	Supplying and fixing in position CI manhole covers with CI frames (Heavy duty) of size 60cm x 60cm of best approved quality with necessary welding and painting with one coat of zinc chromite primer and two coats of epoxy painting complete.(As per instruction of Engineer incharge)as per standard specification etc., complete compying with standard specifications	Nos	4.00	2,407.00	₹	9,628
I	**Waste water pipes**					
	Providing and fixing on wall face nplastidsed-PVC (working pressure 4 kgf per sqm) rain water pipes conforming to IS :4985 including jointing with seal ring conforming to IS: 5382 leaving 10 mm gap for thermal expansion.					
i	110 mm dia PVC pipes fixing	Rmt	4.00	374.90	₹	1,500
ii	110 mm dia PVC-Tees	Nos	1.00	333.95	₹	334
	110 mm dia Elbow pipe	Nos	1.00	275.80	₹	276
	Total				**₹**	**5,28,196**

Estimated costing for Registers:

Measurement sheet of Register					
Sl.n	**Description**	**Unit**	**Quantity**	**Rate in Rs.**	**Amount in Rs.**
A	**Rate for Earthwork- Excavation**				
a	Earth work open excavation in all soils and sub-soils and to full depth as may be directed except in rock requiring blasting inclusive of shoring shuttering, bailing out water wherever necessary and depositing the excavated earth with a lead of 10 mts. within the compound in places shown by the departmental officers and clearing and levelling the site, etc., complete complying with standard specification.				
	Total	Cum	7.38	130.93	₹ 966
b	Removal of excess earth				
	Removal of excess excavated earth from the site and dumping it 1km away from the location.	Cum	7.38	31.50	₹ 232
c	Refilling with excavated earth				
	Refilling with excavated earth other than sand with an initial head load of 100 mts. and depositing the earth as shown by the departmental officers in layers well rammed, watered and consolidated etc. complete complying with standard specification	Cum	5.49	19.50	₹ 107
B	**Plain Cement Concrete (P.C.C), 1:4:8**				
	Cement Concrete 1:4:8 (One Cement, Four sand and eight hard broken stone jelly) using 40 mm gauge hard broken granite stone jelly for foundation including dewatering wherever necessary and laid in layers of not more than 15 cm thick, well rammed, consolidated and curing etc. complete complying with standard specification and as directed by engineer in charge				
	TOTAL D	Cum	0.22	3,598.00	₹ 788
C	**Solid Block masonry**				

	Providing and constructing precast concrete solid blocks with compresive strength not less than 35 Kg per sqm with cement mortar 1:4 masonry with soild blocks of 40x 20x 20 cms conforming to IS 2185/1965 in super structure including the cost of materials, labour charges, scaffolding, curing complete as per specification				
	TOTAL	Cum	0.90	6,674.00	₹ 6,023
D	**Plastering with mortar, 1:5**				
a	Providing 12 mm thick cement plaster in one coat in external surface with 1:5 cement mortar mixed including scaffolding and curing and also complying with standard specifications and instructions of the engineer in charge.	Sqm	3.10	187.80	₹ 581
b	Providing 20 mm thick cement plaster in one coat in internal surface 1:5 cement mortar mixed with water proofing agent , including scaffolding and curing and also complying with standard specifications and instructions of the engineer in charge.	Sqm	3.01	302.800	₹ 911
E	**Manhole**				
	Supplying and fixing in position CI manhole covers with CI frames (Heavy duty) of size 120cm x 120cm of best approved quality with necessary welding and painting with one coat of zinc chromite primer and two coats of epoxy painting complete.(As per instruction of site engineer)as per standard specification etc., complete compying with standard specifications	Nos	1.00	2,700.00	₹ 2,700
F	**Waste water pipes**				

	Providing and fixing uPVC pipes (Soil and waste line) of required diameter conforming to I.S.-13592, and I.S.-4985 to withstand continous internal hydroulic pressure of 6 kg/cm2 including necessary fixtures and fittings, such as bends, tees, single junctions, double junctions and joining with rubber rings and lubricants, on wall by means of clips or in ground including necessary excavation, laying refilling, trench testing etc. complete. (Prior approval of sample and brand by Engineer in charge is necessary before use.)				
i	110 mm dia PVC pipes fixing	Rmt	0.20	200.00	₹ 40
	Total				**₹ 12,349**
	Total for 35 Registers				**4,32,231.02**

Estimated costing for Sludge Storage Room:

	Abstract sheet of Sludge Storage House				
Sl.n	**Description**	**Unit**	**Quantity**	**Rate inRs**	**Amount in Rs**
A	**Rate for Earthwork- Excavation**				
	Earth work in excavation over areas (exceeding 30 cm in depth, 1.5 in width as well as 10 sqm on plan) including disosal of excavated earth, lead upto 50 m and lift upto 1.5 m , disposed earth to be levelled and neatly dressed :				
	Total	cum	95.12	336.80	₹ 32,038
b	Removal of excess earth				
	Removal of excess excavated earth from the site and dumping it 1km away from the location.	Cum	95.12	31.50	₹ 2,996
B	**Plain Cement Concrete (P.C.C), 1:4:8**				
	Cement Concrete 1:4:8 (One Cement, Four sand and eight hard broken stone jelly) using 40 mm gauge hard broken granite stone jelly for foundation including dewatering wherever necessary and laid in layers of not more than 15 cm thick, well rammed, consolidated and curing etc. complete complying with standard specification and as directed by engineer in charge				
	Total PCC	Cum	8.6	3,598.00	₹ 31,029
C	**Reinforced Cement Concrete (R.C.C), M25**				
	Providing and laying in position specified grade of reinforced cement concrete excluding the cost of centring, shuttering, finishing and reinforcement-All work puto plinth level	cum			
	1:1:2 (1 cement:1 coarse sand:2 graded stone aggregate 20mm nominal size)				
	Total RCC	Cum	36.41	6,035.20	₹ 2,19,730
D	**Reinforcement**				

	Supplying, fabricating and placing in position TMT bars (Fe 500) for all RCC works as per design given including cost of steel and G.I. binding wire for placing at all depths of excavation, complete complying with standard specification. (Contractor has to make his own arrangements for the supply of steel, binding wire and for bar bending)				
	Thermo-Mechanically Treated bars TMT Fe-500-20mm dia.				
	Total Reinforcement	KG	4,551.0	53.60	₹ 2,43,934
E	**Centering/ Shuttering**				
	Supplying and erecting centering for sides and soffits including necessary supports and strutting upto 3.29 M height for plane surfaces as detailed below in all floors with all cross bracings using Mild Steel sheets of size 90 x 60 cm and 10 BG stiffened with welded Mild Steel angle of size 25mm x 25mm x 3 mm for boarding laid over silver oak joists of size 10cm x 6.50 cm spaced at abote 90 cm centre to centre and supported by casurina props of 10cm to 13 cm dia spaced at not more than 75 cm centre to centre etc. complete complying with the standard specificaiton. (Payment for centering shall be given after the concrete is laid)				
	For plane surfaces such as RCC floor slab, roof slab, beams, lintels, bed blocks, landing slab, waist slab, portico slabs and beams, etc.	Sqm	86.3	580.00	₹ 50,042
F	**Solid Block masonry**				
	Providing and constructing precast concrete solid blocks with compresive strength not less than 35 Kg per sqm with cement mortar 1:4 masonry with soild blocks of 40x 20x 20 cms to super structure including the cost of materials, labour charges, scaffolding, curing complete as per specification				
	Total	Cum	15.7	4,972.00	₹ 78,160
G	**Plastering with mortar, 1:5**				

	Cement mortar1:5(1 cement:5 coarse sand)12 mm cement plaster of mix: 1:5(1 cement: 5 coarse sand) Cement plaster in course sand.				
	Total	Sqm	159.6	107.40	₹ 17,141
H	**Roof**				
a	Supplying , erecting and fixing in position Pre- fabricated steel structures at all elevations for Canopy using structural steel sections ISMB/ISMC/ISA conforming to IS:2062 , including poly green house sheet, footing for erection cutting, welding or bolting, supply of bolts/nuts/washers etc., complete as per drawings including surface preparation and applying one coat of Zinc Phosphate Primer before erection, one coat after erection and two coats of synthetic enamel paint as per specification after erection and all materials and labour complete. (No welding is permitted at site). The rate quoted shall include cost of bolts, nuts, washers, welding and electrodes and any other consumables required for completing the work. Nut bolts shall not be considered for payment. Theoretical weight of steel sections shall be considered for payment.	Sqm	132.2	2,800.00	₹ 3,70,272
b	Supplying and fixing AC sheet roofing with 6mm thick asbestos cement sheets of fully corrugated (grey colour) of approved quality by drilling holes (and not by punching) with necessary 'J' / 'U' bolts and nuts of 8mm dia of suitable length and providing one set of bitumen washers of 25mm dia and 1.60mm thick for each bolt including protruding portion of bolts in roof shall be covered with bitumen compound etc., complete complying with standard specification and as directed.	Sqm	164.8	498.25	₹ 82,132
	Total				₹ 11,27,473

Estimated costing for Rigid Pavement:

Asbtract sheet of Rigid Pavement					
Sl.n	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
A	**Rate for Earthwork- Excavation**				
	Earth work in excavation over areas (exceeding 30 cm in depth, 1.5 in width as well as 10 sqm on plan) including disosal of excavated earth, lead upto 50 m and lift upto 1.5 m , disposed earth to be levelled and neatly dressed :				
	Total earthwork excavation	cum	1,598.00	130.93	₹ 2,09,226
B	**Sub Grade**				
	Supply and filling excavated areas with 80 dia gravel in layers including watering, compacting with vibratory roller (12 tonne) . Supply of above materials will be done through mechanised means by use of tippers or trucks and appropriate compacting machines for leveling and to achieve desired density				
	TOTAL	cum	1,436.50	592	₹ 8,50,408
C	**Sub-Base course**				
	Supply and filling excavated areas with 40 dia gravel in layers including watering, compacting with vibratory roller (12 Tonne) and as directed by engineer incharge. Supply of above materials will be done through mechanised means by use of tippers or trucks and appropriate compacting machines for levelling and to achieve the desired density				
	TOTAL	cum	430.95	989.200	₹ 4,26,296
D	**WET MIX MACADAM**				
	Providing, laying, spreading and compacting graded stone aggregate to wet mix macadam specification including premixing the Material with water at OMC in mechanical mix plant carriage of mixed Material by tipper to site, laying in uniform layers with paver in sub-base / base course on well prepared surface and compacting with vibratory roller (12 tonne) to achieve the desired density				
	Total	Cum	646.43	1330	₹ 8,59,745
E	**BITUMEN LAYER**				

	Providing and laying bitumen mastic wearing course (as per specifications) with industrial bitumen of grade 85/25 conforming to IS : 702, prepared by using mastic cooker and laid to required level and slope, including providing antiskid surface with bitumen precoated fine grained hard stone chipping of approved size at the rate of 0.005 cum per 10 sqm and at approximate spacing of 10 cm centre to centre in both directions, pressed into surface protruding 1 mm to 4 mm over mastic surface, including cleaning the surface, removal of debris etc. all complete. (Considering bitumen using 10.2% as per MORTH specification).				
	TOTAL	cum	359.13	1540	₹ 5,53,053
F	**Sand Filling**				
	Supplying and filling in foundation, basement, etc with filling 3mm coarse sand	cum	86.190	1031.25	₹ 88,883
G	**Weather coarse**				
	Providing and laying bitumen mastic wearing course (as per specifications) with industrial bitumen of grade 85/25 conforming to IS : 702, prepared by using mastic cooker and laid to required level and slope, including providing antiskid surface with bitumen precoated fine grained hard stone chipping of approved size at the rate of 0.005 cum per 10 sqm and at approximate spacing of 10 cm centre to centre in both directions, pressed into surface protruding 1 mm to 4 mm over mastic surface, including cleaning the surface, removal of debris etc. all complete. (Considering bitumen using 10.2% as per MORTH specification).	Cum	100.20	1540	₹ 1,54,308
	Total				**₹ 31,41,919**

Estimated costing for External Boundary wall:

	Abstract sheet of External Wall				
Sl.n	**Description**	**Unit**	**Quantity**	**Rate inRs**	**Amount in Rs**
A	**Rate for Earthwork- Excavation**				
	Earth work in excavation over areas (exceeding 30 cm in depth, 1.5 in width as well as 10 sqm on plan) including disosal of excavated earth, lead upto 50 m and lift upto 1.5 m , disposed earth to be levelled and neatly dressed :				
	Total	cum	213.75	336.80	₹ 71,991
b	Removal of excess earth				
	Removal of excess excavated earth from the site and dumping it 1km away from the location.	Cum	213.75	31.50	₹ 6,733
B	**Plain Cement Concrete (P.C.C), 1:4:8**				
	Cement Concrete 1:4:8 (One Cement, Four sand and eight hard broken stone jelly) using 40 mm gauge hard broken granite stone jelly for foundation including dewatering wherever necessary and laid in layers of not more than 15 cm thick, well rammed, consolidated and curing etc. complete complying with standard specification and as directed by engineer in charge				
	Total PCC	Cum	11.3	3,598.00	₹ 40,478
C	**Random rubble Stone Masonry**				
	Random rubble Stone Masonry in Cement Mortar 1:6 using best quality of rubble stones for foundation and basement including curing, etc., complete complying with standard specifiction.				
	Total	Cum	410.6	4,972.00	₹ 20,41,628
	Grand Total				₹ 21,60,829

Estimated costing for Operator room:

	Abstract sheet of Operator room				
Sl.n	**Description**	**Unit**	**Quantity**	**Rate in Rs**	**Amount in Rs**
A	**Rate for Earthwork- Excavation**				
a	Earth work in excavation over areas (exceeding 30 cm in depth, 1.5 in width as well as 10 sqm on plan) including disosal of excavated earth, lead upto 50 m and lift upto 1.5 m , disposed earth to be levelled and neatly dressed :				
	Total	cum	41.142	336.80	13857
b	Removal of excess earth				
	Removal of excess excavated earth from the site and dumping it 1km away from the location.	Cum	41.142	31.50	1296
B	**Rubble solling**				
	Supplying and filling in basement with sand gravel mix in the ratio of 1:1with 0.685 Cu.m of sand and 0.667 Cu.m gravel in layers of not more than 15cm thick, well rammed, watered and consolidated etc., complete complying with standard specification.	Cum	14.400	690.00	9936
C	**Plain Cement Concrete (P.C.C), 1:4:8**				
	Cement Concrete 1:4:8 (One Cement, Four sand and eight hard broken stone jelly) using 40 mm gauge hard broken granite stone jelly for foundation including dewatering wherever necessary and laid in layers of not more than 15 cm thick, well rammed, consolidated and curing etc. complete complying with standard specification and as directed by engineer in charge				
	Total PCC	Cum	4.797	3,598.00	17260
D	**Reinforced Cement Concrete (R.C.C), M25**				
	Providing and laying in position specified grade of reinforced cement concrete excluding the cost of centring, shuttering, finishing and reinforcement-All work puto plinth level	cum			

	1:1:2 (1 cement:1 coarse sand:2 graded stone aggregate 20mm nominal size)				
	Total RCC	Cum	17.184	6,035.20	103708.8768
E	**Reinforcement**				
	Supplying, fabricating and placing in position TMT bars (Fe 500) for all RCC works as per design given including cost of steel and G.I. binding wire for placing at all depths of excavation, complete complying with standard specification. (Contractor has to make his own arrangements for the supply of steel, binding wire and for bar bending)				
	Thermo-Mechanically Treated bars TMT Fe-500-20mm dia.				
	Total Reinforcement	KG	2,148.00	53.60	115132.8
F	**Centering/ Shuttering**				
	Supplying and erecting centering for sides and soffits including necessary supports and strutting upto 3.29 M height for plane surfaces as detailed below in all floors with all cross bracings using Mild Steel sheets of size 90 x 60 cm and 10 BG stiffened with welded Mild Steel angle of size 25mm x 25mm x 3 mm for boarding laid over silver oak joists of size 10cm x 6.50 cm spaced at abote 90 cm centre to centre and supported by casurina props of 10cm to 13 cm dia spaced at not more than 75 cm centre to centre etc. complete complying with the standard specificaiton. (Payment for centering shall be given after the concrete is laid)				
	For plane surfaces such as RCC floor slab, roof slab, beams, lintels, bed blocks, landing slab, waist slab, portico slabs and beams, etc.	Sqm	40.1	580.00	23234.8
G	**Solid Block masonry**				
	Providing and constructing precast concrete solid blocks with compresive strength not less than 35 Kg per sqm with cement mortar 1:4 masonry with soild blocks of 40x 20x 20 cms to super structure including the cost of materials, labour charges, scaffolding, curing complete as per specification				

	Total	Cum	12.6	4,972.00	62673
H	**Plastering with mortar, 1:5**				
	Cement mortar1:5(1 cement:5 coarse sand)12 mm cement plaster of mix: 1:5(1 cement: 5 coarse sand) Cement plaster in course sand.				
	Total plastering	Sqm	176.116	107.40	18915
I	**White wash**				
	White washing one coat with freshly burnt white shell lime in all floors including cost of lime, blue powder, fevicol type gum, brushes, scaffolding charges, etc., complete complying with standard specification and as directed by the engineer in charge	Sqm	140.1	11.80	1653
J	**Sanitary fittings**				
a	Supplying and fixing in position best quality cuddapah sink of following sizes including cost of 32mm dia CP waste coupling, 32mm dia PVC waste pipe with rubber plug and chain, 15mm dia brass nipple including fixing the sink in position and testing for leakages etc., complete complying with standard specifications excluding CI brackets. [The sink and specials should be got approved by the Engineer before use on works]	Nos.	2.0	1,527.00	3054
b	Providing and fixing water closet squatting pan (Indian type W.C.pan) with 100 mm sand cast Iron P or S trap, 10 litre low fixtures complete, including cutting and making good the walls andlevel white P.V.C. flushing cistern, including flush pipe, with manually controlled device (handle lever) conforming to IS : 7231, with all fittings and floors wherever required : White Vitreous china Orissa pattern W.C. pan of size 580x440 mm with integral type foot rests	Nos.	1	3049.3	3049.3
K	**Door and Windows**				
	Manufacture and installation of MS steel door with handle including all hinges and frames (Refer Drawing)	Nos.	2.0	2,900.00	5800
	Manufacture and installation of MS steel window with handle including all hinges and frames (Refer Drawing)	Nos.	1.0	1,800.00	1800

L	**Waste water pipes**				
	Providing and fixing on wall face nplastidsed-PVC (working pressure 4 kgf per sqm) rain water pipes conforming to IS :4985 including jointing with seal ring conforming to IS: 5382 leaving 10 mm gap for thermal expansion.				
a	6 inch dia pipe	RMT	3.00	520.28	1560.84
	Total				**₹ 3,82,930**

Estimated costing for external wall:

	Abstract sheet of External Wall				
Sl.n	**Description**	**Unit**	**Quantity**	**Rate inRs**	**Amount in Rs**
A	**Rate for Earthwork- Excavation**				
	Earth work in excavation over areas (exceeding 30 cm in depth, 1.5 in width as well as 10 sqm on plan) including disosal of excavated earth, lead upto 50 m and lift upto 1.5 m , disposed earth to be levelled and neatly dressed :				
	Total	cum	213.75	336.80	₹ 71,991
b	Removal of excess earth				
	Removal of excess excavated earth from the site and dumping it 1km away from the location.	Cum	213.75	31.50	₹ 6,733
B	**Plain Cement Concrete (P.C.C), 1:4:8**				
	Cement Concrete 1:4:8 (One Cement, Four sand and eight hard broken stone jelly) using 40 mm gauge hard broken granite stone jelly for foundation including dewatering wherever necessary and laid in layers of not more than 15 cm thick, well rammed, consolidated and curing etc. complete complying with standard specification and as directed by engineer in charge				
	Total PCC	Cum	11.3	3,598.00	₹ 40,478
C	**Random rubble Stone Masonry**				
	Random rubble Stone Masonry in Cement Mortar 1:6 using best quality of rubble stones for foundation and basement including curing, etc., complete complying with standard specifiction.				
	Total	Cum	410.6	4,972.00	₹ 20,41,628
	Grand Total				₹ 21,60,829

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Sanitation Capacity Building Platform

Goal

To build the capacity of cities and other stakeholders working in urban sanitation to ensure improved delivery of sanitation services through decentralized approaches.

What is the Sanitation Capacity Building Platform?

Sanitation Capacity Building Platform (SCBP) is designed to support and build the capacity of towns/cities to plan and implement decentralized sanitation. The platform also aims to facilitate knowledge and experience sharing among cities on decentralized. Decentralized sanitation is a key solution to accomplish national missions like Swachh Bharat Mission, AMRUT, Smart Cities Mission and Namami Gange programme.

The platform supports the Ministry of Urban Development (MoUD), Govt of India's focus on urban sanitation. It assists states and cities to move beyond open defecation free status by addressing safe disposal and treatment of human faeces.

Assess the needs → Develop a capacity building programme → Coordinate with partners → Provide customized capacity building activities → Monitor progress

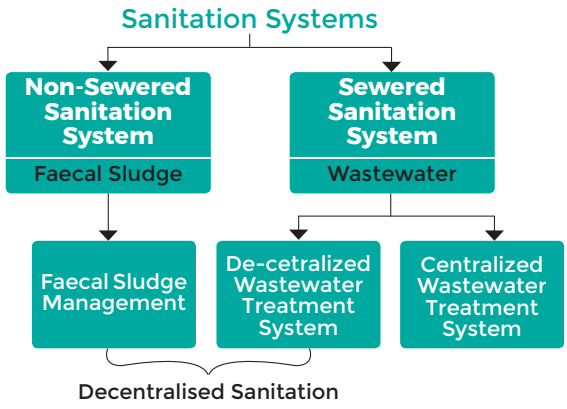
How Does the Platform Work?

National Institute of Urban Affairs (NIUA) is the anchor organization for this platform which comprises a network of partners who are credible national and international expert agencies. These partners include prominent universities, training centres, resource centres, nongovernmental organizations, consultants and experts such as CEPT University, CDD and BORDA, iDeCK, ASCI, CPR, CSE, WASHi and UMC.

NIUA actively reaches out to towns and states to understand the sanitation situation, assess needs, and develop customized capacity building programmes. NIUA then connects each state and city with the appropriate capacity building partners of the platform. The partners deliver capacity building activities for all stakeholders involved in sanitation value chain, including officials from Urban Local Bodies (ULBs), elected representatives and private sector. NIUA responds to requests and enquiries from states and cities.

Why Decentralized Sanitation?

Ambitious goals of various national missions such as Swachh Bharat Mission, AMRUT and the Smart Cities Mission cannot be achieved solely through conventional, centralized wastewater treatment systems. Given that, 49% of the urban population in India relies on on-site sanitation such as septic tanks and pits, decentralized sanitation options such as Faecal Sludge Management (FSM) and Decentralized Wastewater Treatment Systems are very much critical for achieving the goals for urban sanitation under various national missions. Decentralized sanitation options are scientifically proven solutions to complement centralized systems, serving the underserved, particularly in peri-urban areas and informal settlements.



Faecal Sludge Management is the collection and transportation of faecal sludge from containment system, treatment of the sludge in a designated site, and then safe disposal or reuse of the treated sludge. Decentralized Wastewater Treatment Systems comprises of sewers to convey domestic wastewater from a neighbourhood or local catchment to a small, local treatment plant where it is treated through a natural processes without any requirement for external energy to operate the system.

Services Offered

- Undertaking FSM situation assessment and diagnostic study of existing sanitation situation of cities
- Orientation and exposure visits for state and ULB officials and elected representatives for understanding Septage and Faecal Sludge risks and challenges
- Supporting national, state and city level FSM Policy and Regulatory reforms
- Institutional capacity strengthening of nodal state/regional level Training Institutions for delivering high quality FSM Trainings
- Facilitating capacity building activities for stakeholders involved in the FSM value chain - government officials, masons, private sector
- Creating knowledge resources and advocacy material on FSM technology, institutional, legal and financial eco-systems
- Preparation of model Detail Project Report (DPRs) for FSM and Learning materials
- Promoting Behaviour Change for moving beyond Open Defecation free status.

Capacity Building

- Orientation and exposure visits for understanding Septage and Faecal Sludge risks and challenges
- Institutional capacity strengthening through training of trainer programmes
- Capacity building activities for stakeholders involved in the FSM value chain - government officials, masons, private sector
- Creating knowledge resources and advocacy material on FSM technology, institutional, legal and financial eco-systems

Planning

- Baseline data collection on FSM
- FSM situation assessment
- Diagnostic study of existing sanitation situation
- Stakeholder mapping and analysis
- Analysis of legal and institutional framework
- Policy and guideline formulation

Implementation

- Model DPRs for Faecal Sludge Treatment Plants and Decentralized Wastewater Treatment System
- Planning for emptying and transport services
- Transaction advisory for FSM
- Designing of Behaviour Change Strategy

Partners of the Platform

Currently there are 8 partners delivering capacity building services on decentralized sanitation. Partners have extensive experience working in the sanitation sector in India and internationally. They have worked closely with many cities in various states and have an excellent understanding of the context and stakeholders. Additional partners will be added to the platform in the future.

asci Leadership through Learning
CENTRE FOR POLICY RESEARCH
CEPT UNIVERSITY
Consortium for DEWATS Dissemination Society
UMC URBAN MANAGEMENT CENTRE
STEP CENTER FOR STUDY OF SCIENCE, TECHNOLOGY & POLICY
iDeCK
WASH INSTITUTE

NIUA National Institute of Urban Affairs

About NIUA

NIUA is a premier national institute for research, capacity building and dissemination of knowledge in the urban sector, including sanitation. Established in 1976, it is the apex research body for the Ministry of Urban Development (MoUD), Government of India.

NIUA is also the strategic partner of the MoUD in capacity building for providing single window services to the MoUD/ States/ULBs.

The Institute includes amongst its present and former clients, the Ministry of Urban Development (MoUD), the Ministry of Housing & Urban Poverty Alleviation (MoHUPA), Housing and Urban Development Corporation (HUDCO), the Planning Commission of India, City and Industrial Development Corporation (CIDCO) of Maharashtra USAID, World Bank, Asian Development Bank, GIZ, UNICEF, UNEP, UNOPS, Cities Alliance, Bill & Melinda Gates Foundation, Rockefeller Foundation, Global Green Growth Institute (GGGI), and the Bernard van Leer Foundation (BvLF). Some of the major areas of work include:

- Provide research support to MoUD
- Conduct research studies on contemporary urban issues
- Coordinate capacity building and training activities
- Disseminate information through networks and knowledge hubs
- Analyze and promote policy change agenda
- Monitor and evaluate Government of India's urban programs/schemes