DETAILED PROJECT REPORT

FAECAL SLUDGE MANAGEMENT SOLUTIONS

FOR

UNNAO CITY, UTTAR PRADESH

Sanitation and Capacity Building Platform (SCBP)

Faecal Sludge Management Solutions for Unnao City (Uttar Pradesh) under the Sanitation Capacity Building Platform- Version -4

14th September 2017

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Versions

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Prepared By

Consortium for DEWATS Dissemination Society

In Association with

National Institute of Urban Affairs

Bill & Melinda Gates foundation

Government of Uttar Pradesh

Executive Summary of DPR

The town of Unnao is the headquarters of Unnao district in Uttra Pradesh, between Lucknow and Kanpur cities. The Population of Unnao is 177,658. 16 ward in the towns are considered in the generation of faecal sludge which are not part of UGD network planned for the town. The onsite sanitation units of faecal sludge collection in these wards are desludged using mechanical equipment such as vacuum pumps and are currently being disposed in vacant farm lands on the outskirts of the city, which is an unsafe practice considering the associated health and environmental risks.

Consortium for DEWATS Dissemination (CDD) Society, through this DPR, proposes to implement a faecal sludge treatment plant to serve the households not having access to UGD in the city which can handle 32 Kilo Litres per Day (KLD) of faecal sludge emptied. The faecal sludge treatment plant proposes to convert sludge generated from onsite sanitation systems into safe and reusable products.

The technology proposed involves stabilization of sludge in stabilization reactor and drying in sludge drying beds thereby dewatering the sludge. The percolate water is then treated with DEWATS technology using settler, anaerobic filters, planted gravel filter, sand carbon filter and UV treatment. The by products such as bio solids can be reused in agriculture as soil conditioners and treated water can be used for irrigation or safely disposed into the nearby storm drains.

The capital expenditure for this project is estimated at **₹ 4.159 Crores** which includes treatment modules as well as support structures with an area requirement of **9,040 Sqm**. The annual operation and maintenance cost is estimated at **₹ 26.91 Lakhs.**

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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

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 end use 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 Unnao city in Uttar Pradesh.

Scope of DPR

CDD had made a preliminary detailed project report (DPR) for Faecal Sludge Treatment Plant for Unnao city. This DPR was not site specific as initially there was no land available for the proposed FSTP. During submission of the DPR, discussions were held at the Office of the Urban Local Body office on 30th January, 2017, where the objective of the DPR, data collected, methodology and treatment concept were discussed. After discussions, it was recommended to redesign and submit a revised detailed project report with unplanted drying bed as the technology for sludge treatment, as land and funds are available.

The scope of this DPR is to assess the current gaps in sanitation across the city of Unnao 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.

Recently, the AMRUT- PDMC has followed it up with the Unnao Nagar Nigam Parishad (NNP) and set aside a suitable land parcel for FSTP construction. The land is located on the outskirts of Unnao NNP. Based on the specifications and context of the allocated land parcel the following project report is prepared. Also, there were a few changes in the sewerage network plan for the town, where previously planned wards have now been allocated under FSM, thus the new catchment areas have been added for faecal sludge estimation in this DPR.

2. Need for Faecal Sludge Management

Unnao is a city on the Gangetic plains of North India lying between major cities of Lucknow and Kanpur. The geographic position of the city had fueled its growth over the last couple of years. As per the 2011 Census, Unnao has recorded a population growth of 15.11% as compared to the population in 2001. This growth had led to extensive burden on land with Unnao having a population density of 680 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.

Unnao 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/liter) (Board, Ground water quality in shallow aquifers of India, 2010) more than that present in raw sewage. 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. 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 Unnao. 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 Unnao (Uttar Pradesh). The details of the research methodology used in carrying out the study at Unnao 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	Household members ULB	1. Primary custodian of the system 2. User of the infrastructure 3. Operates and maintains the system
	Non-residential places	1. Primary custodian of the system

containment structures-	ULB	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 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

[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

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: Unnao 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 Unnao

Stakeholder	No of Samples
Households	362-374
Non-residential places	13
ULBs	1
Cesspool operator	2

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)
Unnao	33,273	83.30%	27716

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 1: 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 Unnao 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
Unnao	33273	0.607	362	1.1%

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

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

Where:

"n" is the total sample size for Unnao =362

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

Note: During the survey extra households were surveyed and data for a total of 374 HHs were finally collected.

Ward 23 was excluded from the survey as the entire ward had its own sewer network to transport wastewater and did not fit into faecal sludge management planning.

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)
1	1994	1677	6.26%	23
2	1341	1243	4.64%	17
3	1023	461	1.72%	6
4	1051	878	3.28%	12
5	1175	919	3.43%	12
6	829	691	2.58%	9
7	869	779	2.91%	11
8	1747	938	3.50%	13
9	1280	616	2.30%	8
10	1258	1196	4.47%	16
11	1077	843	3.15%	11
12	988	754	2.82%	10
13	983	910	3.40%	12
14	980	954	3.56%	13
15	917	852	3.18%	12
16	824	643	2.40%	9
17	873	856	3.20%	12
18	1083	1010	3.77%	14
19	1396	1065	3.98%	14
20	2413	2278	8.51%	31
21	1478	1163	4.34%	16
22	1123	784	2.93%	11
24	886	866	3.23%	12

25	751	665	2.48%	9
26	1193	1104	4.12%	15
27	717	709	2.65%	10
28	1153	1118	4.18%	15
29	830	801	2.99%	11
TOTAL	**33,232**	**26772**	**100 %**	**362**

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 2: 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
Unnao									
1	1	0	0	0	5	1	0	16	0
2	0	0	0	0	6	2	0	8	0
3	2	0	0	0	2	0	0	1	0
4	0	0	0	0	6	0	0	5	0
5	1	0	0	0	3	2	0	7	0
6	1	0	0	0	5	0	1	1	0
7	1	0	0	0	4	0	0	5	0
8	2	0	0	0	2	1	0	7	0
9	1	0	0	0	3	1	0	3	0
10	0	0	0	0	7	1	0	8	0
11	1	0	0	0	7	0	0	3	0
12	1	0	0	0	5	0	0	4	0
13	0	0	0	0	4	1	0	6	0
14	0	0	0	0	8	1	0	3	0
15	0	0	0	0	10	0	0	1	0
16	1	0	0	0	4	0	0	4	0
17	0	0	0	0	5	0	0	6	0
18	0	0	0	0	5	3	0	5	0
19	2	0	0	0	8	1	1	2	0
20	0	0	0	0	6	0	1	23	0
21	1	0	0	0	4	1	0	9	0
22	2	0	0	0	3	0	0	6	0
24	2	0	0	0	8	0	0	2	0
25	1	0	0	0	4	1	0	2	0
26	1	0	0	0	10	0	0	4	0
27	1	0	0	0	5	0	0	3	0
28	1	0	0	0	12	1	0	1	0
29	1	0	0	0	6	0	0	3	0
TOTAL	**25**	**2**	**2**	**1**	**157**	**18**	**9**	**147**	**1**

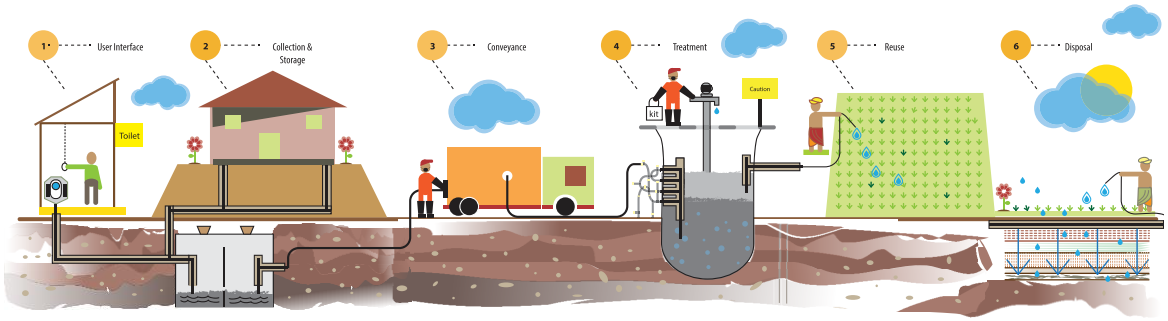
Sample Size Calculation for Non-residential Units, Cesspool Operators, and ULBs

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 Unnao 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 3: 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 Unnao- Existing Situation in Unnao

The town of Unnao is the headquarters of Unnao district in Uttar Pradesh. The District lies between Latitude 26°8' N & 27°2' N and Longitude 80°3' E & 81°3' E. It shares its borders on the North with District Hardoi , on the East with District Lucknow, on the South with District Rae Bareli and on the West it is bound the Ganga which separates it from districts of Kanpur

& Fatehpur. The Geographical area of the city is 21 sq.Km. It lies on the highway connecting important cities: Kanpur and Lucknow. Figure 4 shows a map with location of Unnao City.

Figure 4: Unnao Location in UP

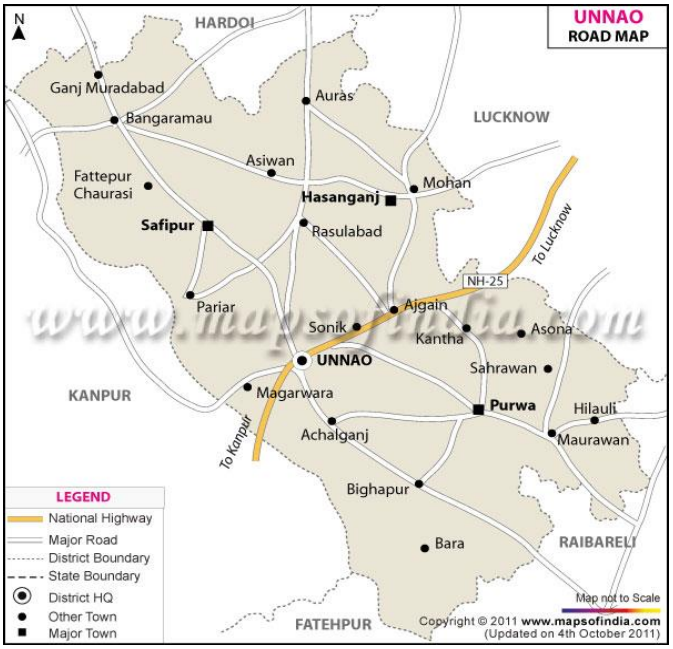


Figure 5: Unnao City

Table 8: Population Information

Population	
Total	177,658
Male	93,021
Female	84,637

Decadal Population Growth Rate	15.11%
Population Density	680 person per sq km
Total No of Households	33,273

Topography and Climate

Unnao lies in the great plains of Ganges and hence the land is highly fertile. The soil is mostly alluvial. The Ganges separates Unnao from Kanpur district. The district is bounded by river Ganges in the west and the river Sai in the east. The entire district falling in Sai Sub-basin of the Ganges basin represents flat topography. The irrigation in the district takes place through Sharda Canal network system and tube wells and about 92% of the district area is under cultivation through these canal systems.

Unnao has a warm tropical climate with the hottest month average temperature recording of 33 °C and the average coldest month temperature of 15 °C.

Table 10 below gives the climate information for Unnao City.

Table 9: Climate Information

Climate Information	
Hottest Month	June (33 °C avg)
Coldest Month	January (15 °C avg)
Wettest Month	July (194.7 mm avg)
Windiest Month	June (9 km/h avg)
Annual Rainfall	670.3 mm (per year)
Average Humidity	50%

Water Supply

Current Situation

According to the ULB, around 10,000 holdings have access to piped water supply which is provided by the ULB. Around 11 MLD of water is supplied to the citizens per day. There are 9 active overhead tanks in the city of capacities 650 KLD, 532 KLD, 112.50 KLD, 150KLD, 350KLD, 1200 KLD, 1500 KLD and 400 KLD from which water is supplied twice daily.

Ground water table in Unnao 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 10000 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. 39% of households claimed to have access to bore well within their premises, 14 % households had access to community hand pumps and similarly 8.53% households had access to individual hand pumps, figure 6 represents the classification of various water sources. Households which had access to pipe water supply paid a fixed monthly fee to the ULB ranging between Rs.50 - Rs.100, however no basis for such variation was found. While only 10000 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.

Figure 6: Water Sources as per Survey 2016

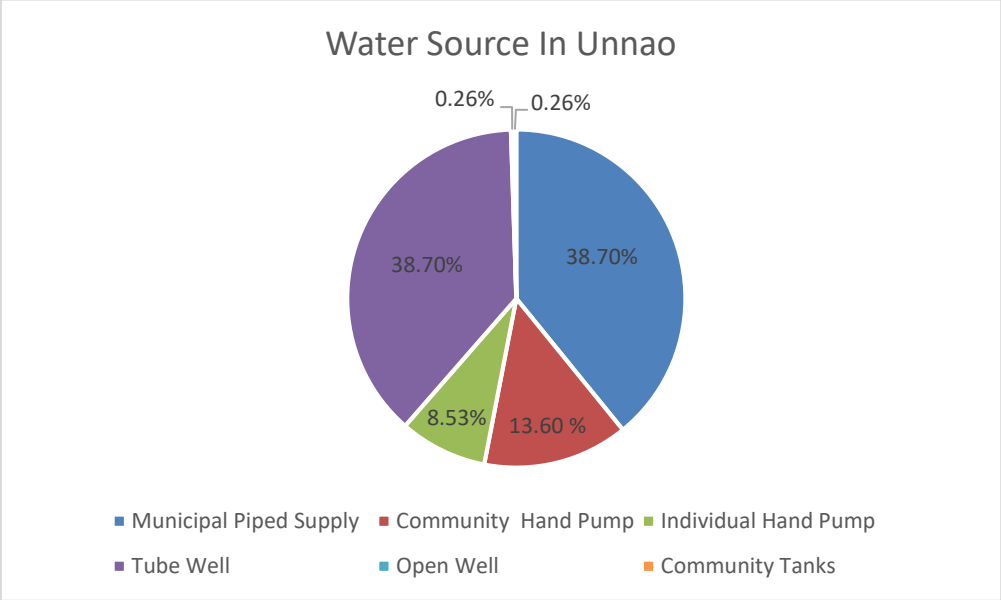


Figure 7: Source of Drinking Water: Community hand pumps

Sanitation Infrastructure

User Interface and containment

According to 2011 census, Unnao has individual toilet coverage of 83.3%, 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. 91% 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.

Figure 8: Toilet with Containment Unit

In the survey conducted, 97.3 % households had rectangular leach pits as containment for black water, while the remaining 2.7 % 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.

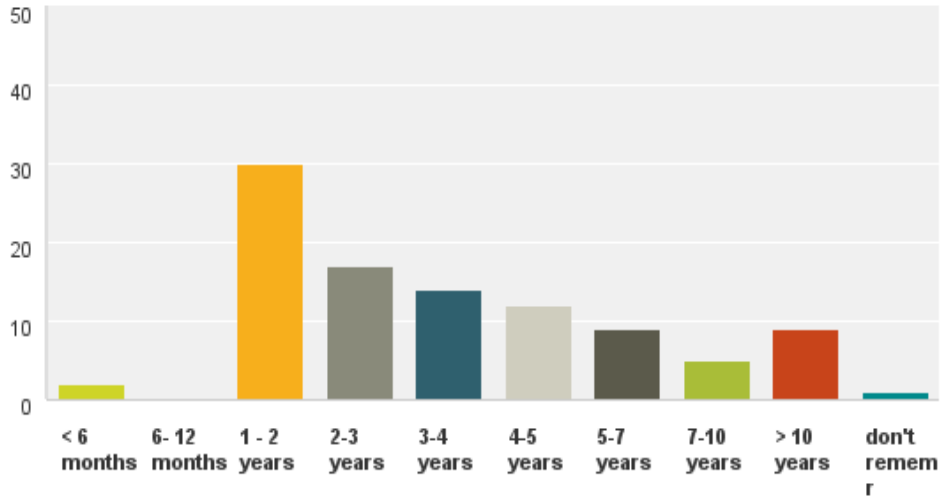
79 % of the Rectangular containment units' resembled septic tanks in the construction and had elements such as baffle wall, these tanks were common across the clusters as they had huge storage volumes, which were indeed preferred by the household. The sizes of these tanks varied between 2 – 45 M^3. In general the depth of these tanks varies between 4 – 15 feet. 87 % of these tanks claimed to be lined at the bottom, while 81 % of septic tanks claimed to have water tight walls.

Figure 9: Outlet of a containment unit drains directly into the drains in the street

Figure 10: Outlet of a containment unit drains directly into a drain

Only 42 % 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 79 % 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.



Single pits were predominant compared to twin pits, there are only a few twin pits present in the city.

Single Pits varied in volume ranging from 1.0 to 5.6 M^3, while the diameter and depths were in the range of 1 – 2 meters. 44.44% of these single pits had their covers temporarily fixed while 33.33% of the covers were cemented to the pit and the remaining 22.22 % 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. Unnao city is serviced by desludging vehicles owned either by the private operator or those owned by the ULB (Unnao Nagar Nigam). Private operators serve from Kanpur and they operate demand based and provide service as and when they receive a request.

Figure 11: Cesspool Operator Vehicles

Private operators are most preferred by the household for desludging owing to their large pipes available for desludging. This makes it easier for them to easily access households located in small lanes. Of the two operators surveyed the municipal operator has well-established business in collection and transportation of faecal sludge, they have been in this field for the past 7 -8 years and have 1 truck.

Operation Modalities

The ULB desludging operator serves on an average 40 trips every month. The months of June, July, August seem to generate more demand for desludging, this can also be related to the rains in Unnao which can lead to the containment units filling faster. This observation also

reiterates to some extent the rain water leaching into containment units because of their semi pervious wall or base.

Desludging charges are typically fixed per household and is calculated based on a contract rather than the number of trips required to empty the contents. The municipal Operator charge Rs. 750 for households and the Private operator charged between Rs.1000-1400 per trip.

Figure 12: Desludging from a soak pit

The municipal Operator claimed that there were some pockets within Unnao city such as- Babuganj, Kila, Kesarganj and Bhuri Devi which was inaccessible for desludging due to small access roads. Households in such areas preferred private operators for their longer pipe lengths and better suction machines.

Figure 13: Narrow roads that make access impossible for desludging vehicles

For private 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 private operators provide an additional service of fixing and

plastering the manhole once the desludging is complete for the HHs. Containment units were usually sealed on the top by cement and had to be broken open using crowbar and hammer. For Municipal operators once 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 Unnao; operators can empty 3 – 4 M^3 of sludge in 12– 15 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 usually 20 – 30 feet in length and 4 inch in diameter. The private operators had a longer pipe length of 100 feet with 3 inch diameter pipes.

Post collection, the private operator transported the faecal sludge to areas such as farmlands present 2-4 km outside the city in an area called "*Babakheda Kila*" ,it was unclear who these farmlands belonged to. While the municipal operator transported it to natural drains present on the outskirts of the city. To let out the sludge, the tank is vented and the same valve used for suction is opened, a small hose pipe is attached at this valve to dispose it away from the vehicle.

Infrastructure

For both cesspool operators the vacuum suction system and the collection tank are mounted on a tractor with an overall width of 3 meters. Trucks usually were defined based on the capacity of the tank; the two trucks observed were of 3000 and 4000 litre capacity. Suction in these systems is established through vacuum pumps which are powered by a separate arrangement (shaft) from the main vehicle engine. The most common problems associated with the system were that of vacuum pump breakdown which would lead to a few days of non-operation. The pumps usually breakdown once or twice a year and there is a locally available mechanic to repair these pumps.

Disposal and Reuse

The collected faecal sludge from private operators and municipal operators are disposed into farmlands directly on the surface or in drains located at the outskirts of Unnao. The municipal operator disposes the faecal sludge in areas called Gadankheda and Chandamadi located on the outskirts of the city near the highway.

Currently faecal sludge is not being reused and most people seem new to the concept of reusing faecal sludge as soil nutrient enhancer. This may be due to the fact that most of the soil is extremely fertile in that region as it is in the Indo-Gangetic plain.

Figure 14: Disposal Site

Figure 15: Disposal Site

Solid waste

The Municipality is in charge of solid waste management in Unnao. There is door to door solid waste collection in five wards – Ward 5, 10, 15, 19 and 23. As of now the ULB does not charge any fee for this collection. There is a low lying land area near the National Highway of Lucknow and Kanpur where the solid waste collected is dumped. The collection and transportation of waste is outsourced to a private operator for a fee paid by ULB.

The remaining households dispose their solid wastes haphazardly without considering health and hygiene condition of the area. 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

In Unnao, systematic drainage facilities have not been constructed. Surface drainage along on the both sides of the road has been constructed but not maintained properly. Surface drainage is open and overflowing and it is also filled with solid waste.

Figure 16: Drains in Unnao

Ward 23 is the only ward in Unnao that has its own sewer network and collection system to collect the wastewater. This wastewater is collected and disposed of in a drain nearby called *Adarsh Nagar Nala*.

Figure 17: Location of Collection System in Ward 23

Figure 18: Collection System in Ward 23

Institutional set up

Unnao City is divided into 29 wards or 12 zones. Unnao Municipality has a total strength of 335 staff people. Out of which, there is one sanitary inspector and 12 hawaldars who looks after the management of collection and disposal of solid waste, cleaning of drains.

Figure 19: ULB Meeting at Unnao

Unnao City does not have a City Sanitation Plan (CSP) for their municipality. City has already started the work of preparation of Detailed Project Report for Sewage Treatment Plant. The work for preparation of DPR is under progress and is being done UP Jal Nigam- a parastatal agency. It has been informed that the STP would tap a major drain of the city and treat the sewage flowing in those drains. It has also been informed that sewer network would be laid under AMRUT funding and funding for construction of STP would be taken from Namami Gange. Also, laying of sewer lines would be done in next phase. However, it was seen that the state and ULB is encouraging the idea of faecal sludge management and to construct septic tanks where they are absent. This initiation from the state explains the urgent hour of the city to treat the faecal sludge/ sewerage efficiently.

As per the Municipal Act, Unnao Municipality performs functions, namely, obligatory functions such as maintenance of roads, street lights, sanitation, water supply, registration of births and deaths, public immunization and regulation of buildings; and discretionary functions such as, parks, schools, hospitals, libraries etc., There are separate departments for the performance of these functions besides an administrative and accounts department. The following table shows the organogram of the Municipality.

Table 10: Unnao ULB Departments and Activities

Unnao Nagar Nigam				
Department	**Civil Dept**	**Health Dept**	**Tax Dept**	**Water Works Dept**
Activities	Road and Drainage	Sanitation Solid waste Public Toilets		Water Supply Pipeline Maintenance

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 management rests primarily with the Unnao N.N.P, with the technical support of Jal Nigam. Private sector role is currently limited to provision of services for desludging and construction of onsite sanitation systems at the household level. The below recommendations are made for improvement in the user interface and containment components of the faecal sludge value chain;

1. During the course of data collection for the preparation of this DPR, it was found that no updated status on open defecation and individual toilets were available with the NNP. It is hence recommended as first steps to carry out a survey and assess the number of housholds with non individual or insanitary toilets.
2. ULB must ensure construction of individual toilets or, if not possible provision of community or public toilets for reducing the extent of open defecation. In addition the ULB must also plan for conversion of household level insaitary latrines to latrines with standard containment units.
3. During the survey it was observed that many households have adopted to un-scientific methods for construction of containment units, which leads to inefficient treatment of wastewater and percolation into the ground further leading to ground water contamination, as evident from data available from various ground water quality studies. As a result it is suggested that these un-scientific containment systems be mapped and measures taken either through incentive or regulation to convert them into standard containment systems as prescribed under chapter 9 of CPHEEO manual on sewerage and sewage treatment.
4. The desludging frequency for the containment units varied widely between 6 months to greater than 15 years, with most households falling in “greater than 5 years” catergory. As and when the desludging frequency increase, the solid accumulation in the containment units exceed the designed levels and thereby reduce the treatment efficiency, leading to high organic pollutants directly being dumped from the outlet of such containment units into nearby drains, which in turn flow into major rivers such as Ganga. It is hence proposed that the ULB undertake and propose regulations for desludging individual households within the designed timeperiods or undertake schedule desludging. It is evident that the ULB also needs to conduct IEC and Behaviour change campaings emphasizing on the importance of construction of standard containment units and desludging at appropriate intervals.

6. Faecal Sludge Conveyance in Unnao

Unnao 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.

Unnao, 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	Unnao
Approx. Number of Households	33048
Number of HH having sewer connections	3000
HH having on-site containment	25906
HH without toilet(OD)	3992
HH using public toilet	150
Number of cesspool vehicles present in the town	2 govt , 1 private
Volume of the cesspool vehicles operating	Government vehicle -3500 Lts (each) Private operator-4000 Lts
Average size of the septic tank/pit**	7-8m^3
Capacity of proposed Faecal sludge treatment plant per day	32 Cubic metre (Refer Section 8 for design capcity details)

*based on the survey done with 374 HH in Unnao

**based on the survey done with 374 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 Unnao 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 drain near Police lines or at the solid waste disposal site location.

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 onsite snattaion systems (OSS) when it gets filled, and transport the faecal sludge to a faecal sludge treatment plant. Technology is critical to bring quality, consistency and compliance to this activity.

Based on a study done by CDD in Unnao, 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, a written request and pay a fixed fee and submit the photocopy of the receipt at the office. The service would be provided mostly in 2-3 days and in case the pit/septic tank couldn't be desludged due to reasons such as inaccessibility or other operational difficulties, the fee is refunded

b) No customer complaint redressal mechanism is available. This would lead to 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

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 geo-tagged to identify desludging intervals. 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 or the local municipal office. The data required for updating the system is from desludging service 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 to monitor disposal points (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 point of sale invoice to the customer. This would ease the payment and maintain the records for transparency.

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 Unnao.

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 Infrastructure - Conveyance

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. There is another cesspool truck which is operated by private operator and is of capacity 4000 Lts.
- The faecal sludge generation in Unnao 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 five cesspool vehicles of different capacities as discussed below,

Table 12: Cesspool Vehicle Details*

Sl. No.	Capacity of vehicle in Lts	No. of cesspool vehicles	No. of trips per day	Faecal sludge which can be collected per day in Lts
1	4000	3	3	27000
2	1000	2	3	6000
			Total	**32000**

- Integrate the trucks with GPS 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.

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

Sl.No	Details		Financial Requirements estimation for one vehicle	No. of vehicles	Total
1	Cesspool Vehicle	4000 Lts Capacity	25 Lakh INR*	3	75 Lakh INR
		1000 Lts Capacity	10 Lakh INR*	2	20 Lakh INR
2	Operation & maintenance of cesspool truck/sucking machine including GPS and GPS tracking per annum(10% of CapEx)				
	4000 Lts Capacity	25 Lakh INR	2.5 Lakh INR	3	7.5Lakh INR
	1000 Lts Capacity	10 Lakh INR	1.0 Lakh INR	2	2 Lakh INR

*Rates derived from market

7. Criteria Adopted For Design

7.1 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 Unnao

The total population of Unnao in the year 2011, as per census was 177658. Considering previous growth rates and estimating for the future, by the year 2027 the estimated population of the city would be 2,40,000. This assumes a decadal growth rate of 35%.

According to the documents and details provided by officials of UP jal Nigal, there is a proposal for a sewerage system along with a treatment plant to be implemented in Unnao covering 18 out of the 29 wards. Households in rest of the wards do not have any immediate plans of getting connected to under ground drainage system and hence would continue to use onsite containment units thereby necessitating the need for faecal sludge management. 16 wards in Unnao had a population of 100773 as per 2011 census as compared to 177658 for the entire city, contributing to 56.7% of the city's population. Assuming a similar growth rate of 35% for these 16 wards, the population for the year 2033 would be 136898.

Since, the DPR is intented to compliment the proposed sewerage system, faecal sludge management planning is carried out only for the 16 wards[4] (Wards 10,16, 18, 21, 22, 2, 3,7,9,12,13,17,19,20,26,29) 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 frequencies were used for estimating the faecal sludge collected at the city level.

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

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 Unnao / Households surveyed

=1.44 * 18710/ 374

=**72 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

=0.38* 50[5] / 13

=**1.5 m^3 per day**

Hence, the total faecal sludge estimated for the city is 72 + 1.4 = 73.5, say 74 m^3 per day.

Note: For the purpose of calculation, households which 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:

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

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 Unnao City as per the survey data there are two vehicles of capacities 3m^3 and 4 m^3, then total volume of faecal sludge that can be desludged per day is:

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

= 3 * 2 * 1= **6 m^3 per day**

b) For private 4 m3 vehicle= Capacity of Vehicle * No of trips per day * No of vehicles

= 4 * 1 * 1= **4 m^3 per day**

Estimated volume of faecal sludge currently collected as per demand: 10 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 20 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:

Ward number	Ward name	Pop 2011	Pop 2018	Pop 2033
10	Civil line central	6220	6715	7400
16	Kishori khera	5024	5582	6580
18	Civil line kalyani	5837	6011	9170
21	Lokeya khera	7272	7523	10160
22	Daroga bagh	5881	6455	7975
2	Adarsh nagar	7437	7616	8556
3	Shekhpur	5687	10340	15600
7	Jawahar nagar	5065	5098	5520
9	Akrampur	7406	8977	10125
12	Patharkata colony	5463	5508	6883
13	A B nagar south	4872	5113	6161
17	Gandhi nagar	4910	4999	5418

19	Talib saray	7877	8440	10450
20	Hiran nagar	9800	10316	12900
26	A B nagar north	6561	6971	8300
29	Qila	5461	5465	5700
Total		100773	111129	136898
Floating population(5%)		5039	5556	6845
Total population		105811	116685	143742
FS generated		22.22	24.50	30.18

Population of the 16 wards for the year 2033: 136898 persons

Floating population assumed for these 16 wards (5% of actual resident population): 6845 persons

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

Sludge accumulation rate per day for: 143742 x 0.00021 = 30.18 m^3

Adding 5% assumed contribution of faecal sludge by Non-residential properties= 30.18 x 1.05= 31.689 m^3

Total Sludge accumulation per day: ~32 m^3

Estimation of treatment Quantity

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

Method of estimation	Estimated FS volume per day
Primary survey - Volumetric	74 m^3
Demand based estimation	20 m^3
Population based estimation	32 m^3

Comparing the three methods, the primary survey estimates the faecal sludge volume as almost 3 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 16 wards out of 29. 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 20 m^3, setting up a treatment plant for 74 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 volumentric 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 administrered within the ULB and till then the excess of capacity is underutilized leading to asset deteroration.

Unnao is growing rapidly in south and north western regions. Considering the fact that the tentative land available for FSTP construction is on eastern 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 deteroration over long time of underutilization, it is recommended to build a treatment plant using quantities estimated through population or demand methods. The proposed volume of faecal sludge estimated for which the treatment facility is to be designed is 32 m^3 per day.

7.2 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.

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 Unnao the toilets in the residential households utilise pour flush facility followed by septic tanks. In Unnao, 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 Unnao, 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 Unnao 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 Unnao. 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 Unnao, 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 Unnao is enumerated in Table 17.

Table 14: Physical and Chemical Characteristics of faecal sludge from one Sample in Unnao

Parameters	Feacal Sludge Sample (30/09/2016)
pH	7.5
Alkalinity	10008
Ammonium	<500
Phosphates	240
COD	38650
Total Solids	58163
Volatile Solids	20745

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. For the purpose a designing a faecal sludge treatment plant for Unnao the following characterestics of faecal sludge are assumed:

Table 15 Assumed parameters

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

7.3 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.

7.4 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.

7.5 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.

7.6 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.

8. 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 Unnao 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 Unnao, 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.

8.1 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 16: 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
4.	Liquid Wastewater Treatment	Settler + Anaerobic Filter Chamber
		Vertical Planted Gravel Filter
5.	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 Unnao 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 17: 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 trans piration	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 sludgecan 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 to biogas and fertilising slurry	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.
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 Unnao.

8.2 Treatment Concept

The treatment concept proposed for faecal sludge treatment in Unnao 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 Unnao the design has taken into consideration minimum energy and minimum operation and maintenance requirement.

Treatment Stages and Modules adopted:

Table 18: 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 Unnao

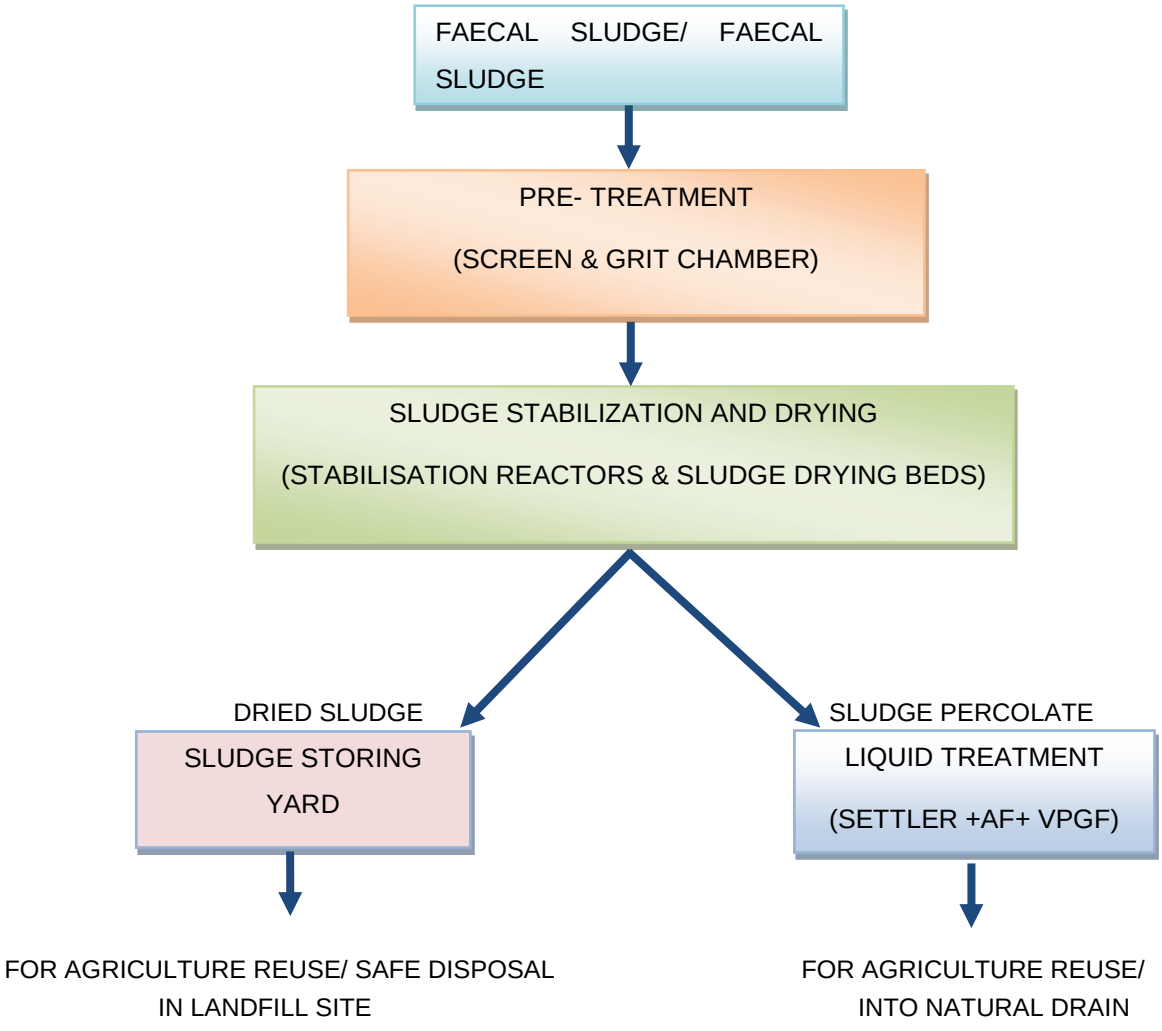
This feacal sludge treatment unit is designed for 32 cum capacity. The stabilization and the drying part of the treatment process is divided into 4 modules of 8 m^3 each to ensure effective digestion. The faecal sludge from households of Unnao community would be conveyed 6 days in a week to the treatment 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 Bed (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 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 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 horizontal 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 **113 m x 80 m.**

Line Diagram Showing Treatment process.



8.3 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 (three 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 Unnao 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 (three 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.

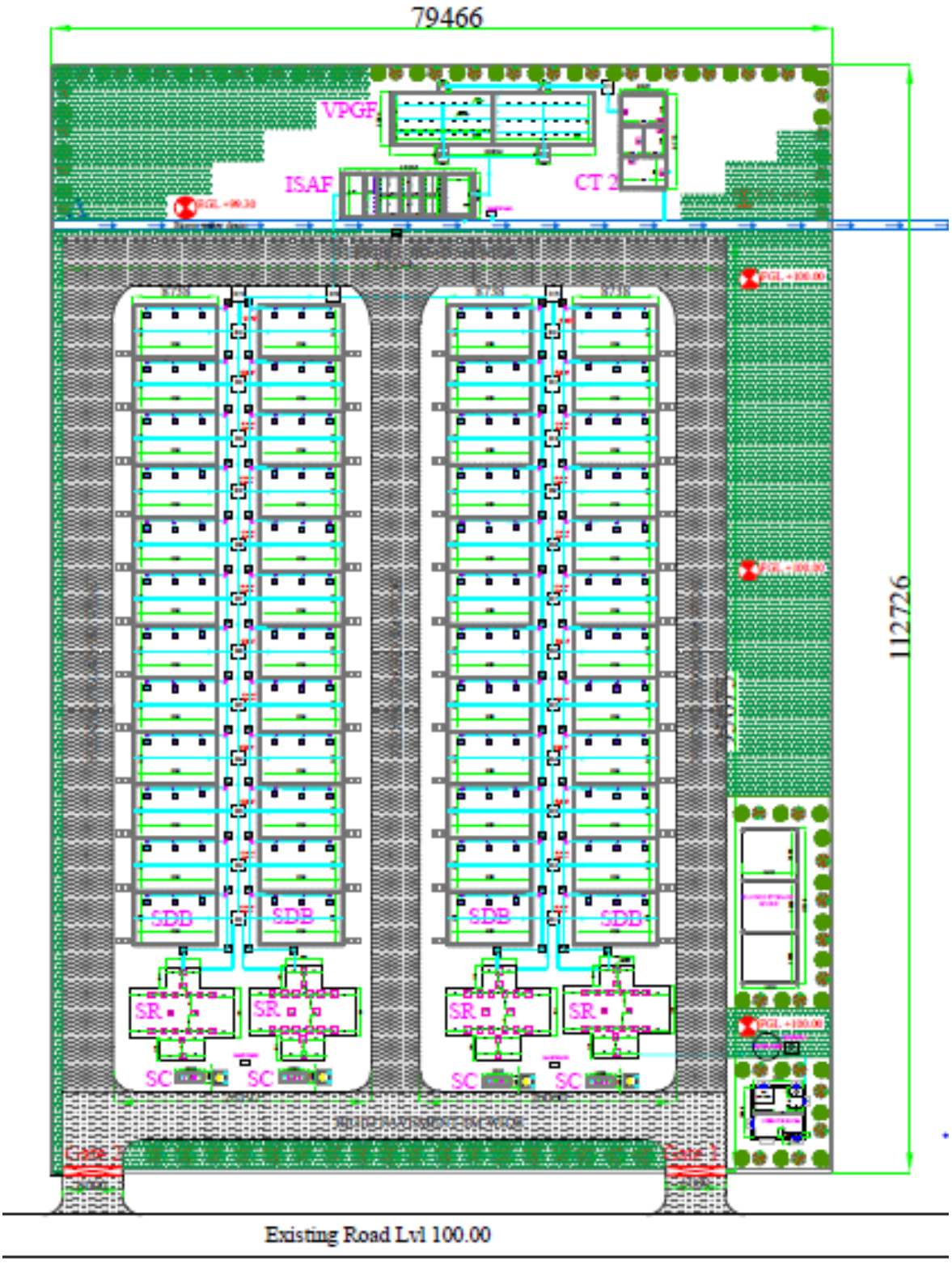
The treated wastewater from the anaerobic reactor is further treated using aerobic treatment process using the Vertical Planted Gravel Filter helps in the reduction of organic matter, removal of odour and color and hygienization.

8.4 Area Requirement For Proposed FSTP

Table 19 Design Specifications of Sludge Percolate Treatment Modules

Sl.No	Modules	Nos	Area (sq.m)	Total Area (sq.m)
1	Screening and Grit Chamber	4	5.87	23.48
2	Stabilization Reactor	4	70.60	282.4
3	Sludge Drying Bed	48	47.5	2280
4	Settler+AF+CT	1	61.44	61.44
5	Vertical Planted Gravel Filter	1	117.4	117.4
Total area for treatment modules				**2764.72**
Total area for supporting structures				**6275.28**
Total FSTP Area				**9040 m^2**

8.5 Area Requirement For Proposed FSTP



9. 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:

9.1 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 20: 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

9.2 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 21: Treated water characteristics

Parameters	Characteristics of treated water
P^H	6.5-9
Temperature	25 -35 degree
BOD at 5 days mg/L	<10

COD mg/L	<50
Total suspended solids mg/L	<20
Faecal coliform per 100 mL	<100
Total Nitrogen mg/L	< 10

10. Electrical and Mechanical Components of the system

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

- 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 need to be provided along the access road within the Treatment plant at intervals.

Table 22 Pump details

Sl No	Pump		Pump details			
	From	**Delivery**	kW	Discharge	Head	Nos
1	Stabilisation reactor 1	Sludge drying bed	2.5	10 cum/hr	15m	4W + 1S
2	Collection tank 1	V-PGF	1.5	5 cum/hr	5m	1W+1S
4	Intermediate collection tank	Sand and carbon filter	1	5 cum/hr	5 m	1W + 1S
5	Borewell pump	Overhead tanks	3	5 cum/hr	30 m	1W
6	Water sump	Overhead tank	0.5	2 cum/hr	5 m	1W

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. Plug valves to be used in the conveyance and piping of sludge, i.e total solids in excess of 1%. For conveyance of treated water or percolate, ball valve to be used.

Pipe material and sizes

Table 23 : Pipe material

SI no	Pipe Material	Diameters used	Remarks
1	UPVC	110mm,160mm	None pressurized. i.e. gravity flow pipes
2	SS 304	110mm, 65mm	All pressurized pipes for pumping sludge from SR
3	HDPE	110mm, 65 mm	For pipes below 1 metre ground filling

Slope

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

Table 24: Slope Details

SI 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	1:200	Storm water drain

Registers

The sizes of the register are based on the Depth of the sewer pipe and are provided in the table below:

Table 25: Register Details

Sl.No	Depth of the Sewer Pipe	Size of the Register
1	0m to 1m	0.7m x 0.7m
2	1m to 1.5m	1 m x 1 m
3	1.5m to 2m	1 m x 1m

11. Freshwater Consumption at FSTP[6]

The Faecal sludge Treatment Process will not consume any water.

The fresh water will be consumed in the following places within the FSTP location.

1. Toilets within the operator Room
   2 operators and 3 helpers/ day- 45 lts/person/day

   = **225 lts/day**

2. For washing hands and their body
   2 operators and 3 helpers/ day- 40 lts/person/day

   = **200 lts/day**

The Blackwater from the Toilet is connected to 1st chamber of Stabilization reactor. By this we make sure that waste water from the toilets is treated on site.

3. For cleaning the flexible hose (4 Nos) at Sludge drying bed.
   30 lts of water/hose

   = **120 lts/day**

4. Backflushing of sand and carbon filter: 500 litres per day

The wastewater will be connected to inlet of settler.

Total Consumption/day = 1050 lts = 1.05 cum/day[7]

[6] Here water usage for washing trucks not included. The trucks are not cleaned at FSTP site but elsewhere as deemed suitable by ULB.

[7] Only freshwater consumption, for gardening and irrigation, treated water will be used

12. Design Description and Schematic of the Proposed Treatment Modules

12.1 Screen 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 Unnao municipality.

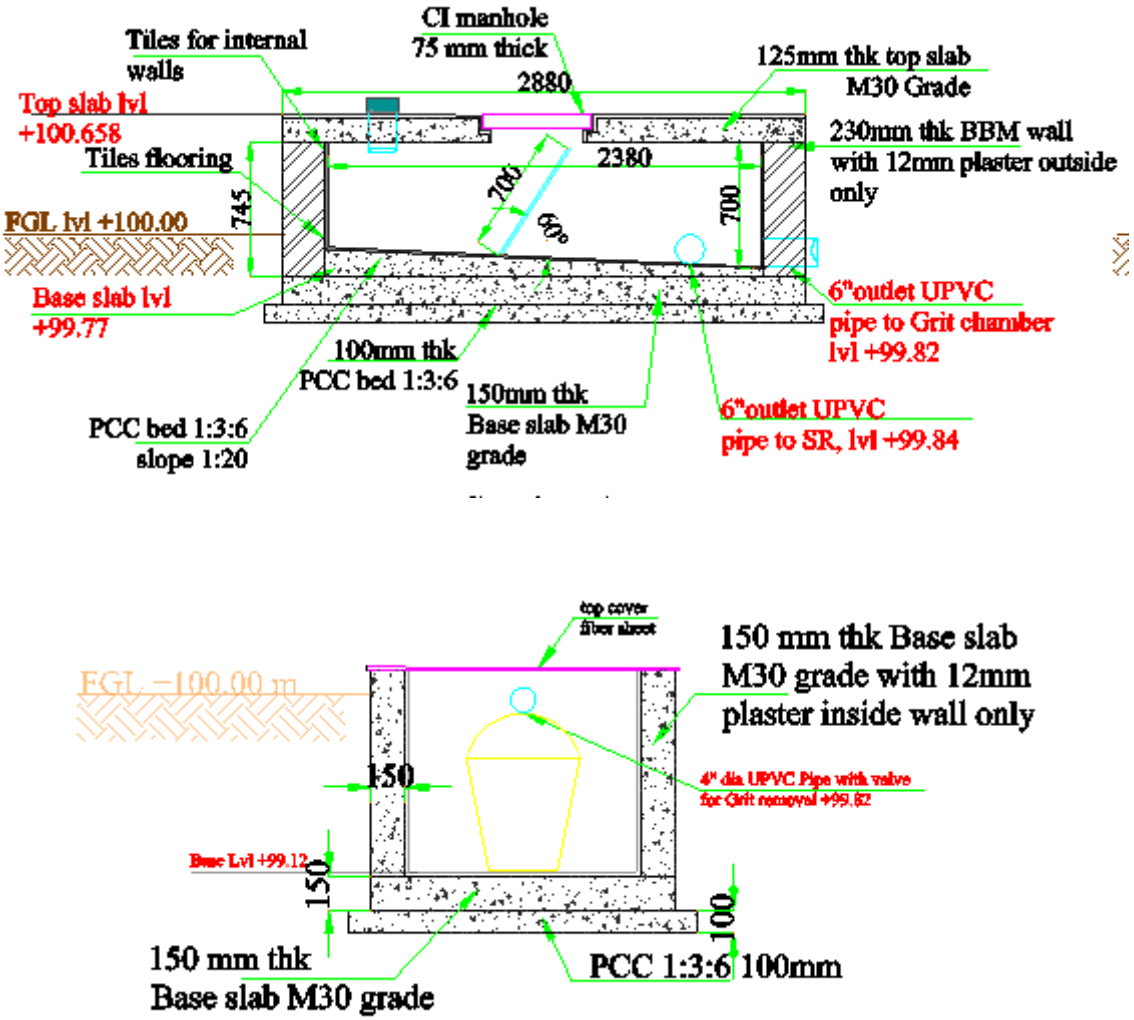
Figure 20: Screening Chamber

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 varies between 30 to 60 seconds.

Table 26 Specifications for Screen chamber

Parameters	Unit	Values
Area required	m2	12
Retention time	Seconds	3 minutes
Number of screen and grit Chambers		4 numbers

Figure 21: Cross section of Screening and Grit Chmaber



12.2 Stabilisation Reactor

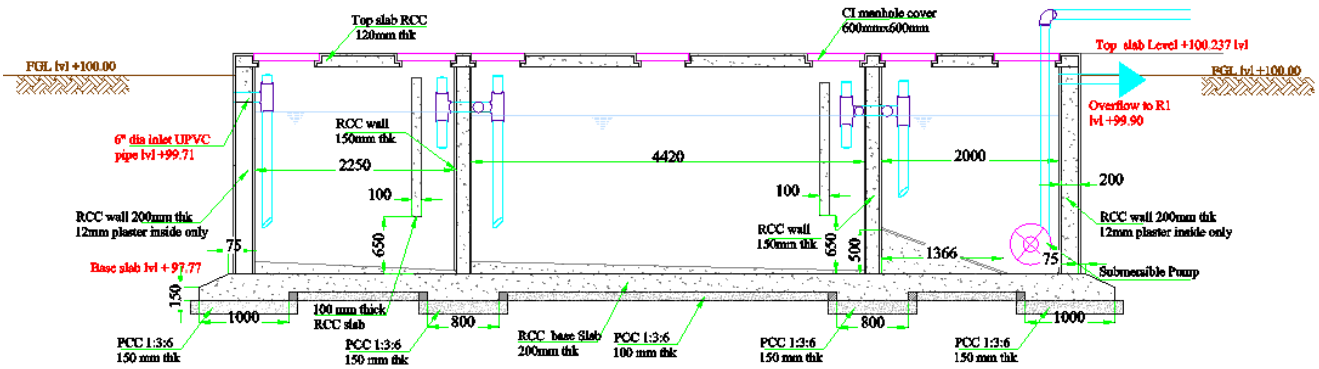
The main objective of the stabilization reactor is to allow the sludge to digest anaerobically which leads to reduced organic load and better dewater-ability. The stabilization reactor has 3 chambers. The first chamber has a retention time of 2 days and assists in homogenization of sludge. During the 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 27 Specifications of Stabilisation Reactor

Parameters	Unit	Values
No of chamber	No	3
Sludge treatment capacity per day	m^3	8
Total Volume of Tank	m^3	98.3
Retention time	Days	12
Slurry disposal into the drying bed	Day	Every day : 8 M^3

Figure 22: 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 Unnao,in order to ensure proper drying of the sludge, a maximum of 11 days of drying period is proposed and accordingly the size of each drying bed is calculated.

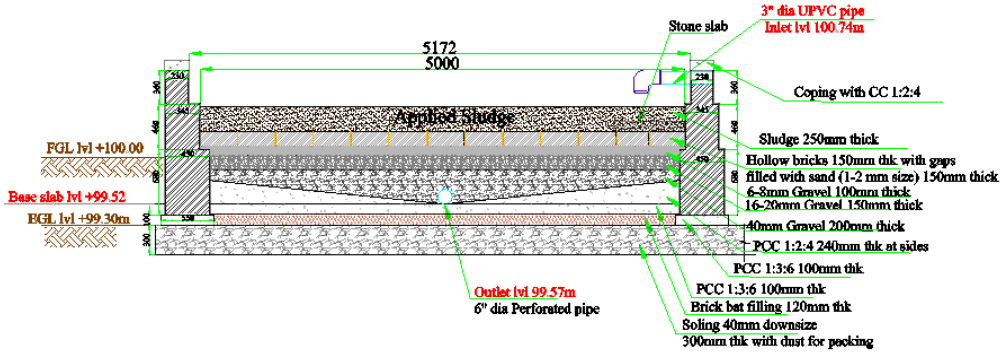
Figure 23 Sludge drying bed

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 28: Specifications of Sludge Drying Bed

Parameters	Unit	Values
Total number of beds	-	48
Treatment volume of each bed	m^3	8
Estimated volume of Solid retained	%	30
Area required	m^2	47.5 m^2 per bed
Slurry feeding frequency	days	12 days
Slurry drying period	days	11
BOD outlet (percolate)	mg / L	600
COD outlet (percolate)	mg / L	1500

Figure 24: Cross Section of Sludge Drying Bed



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 29 Specification for Settler Design

Sl No	Particulars	Unit	Values
1	Discharge (Q daily)	m^3/d	20
2	Time of peak flow (peak)	Hrs	4
3	Max. Chemical Oxygen Demand (COD in)	mg/l	1500
4	Max. Biological Oxygen Demand (BOD in)	mg/l	600
5	Hydraulic Retention Time (HRT)	Hrs	2
6	Area required	m^2	17

Table 30 Specifications of Anaerobic filter design

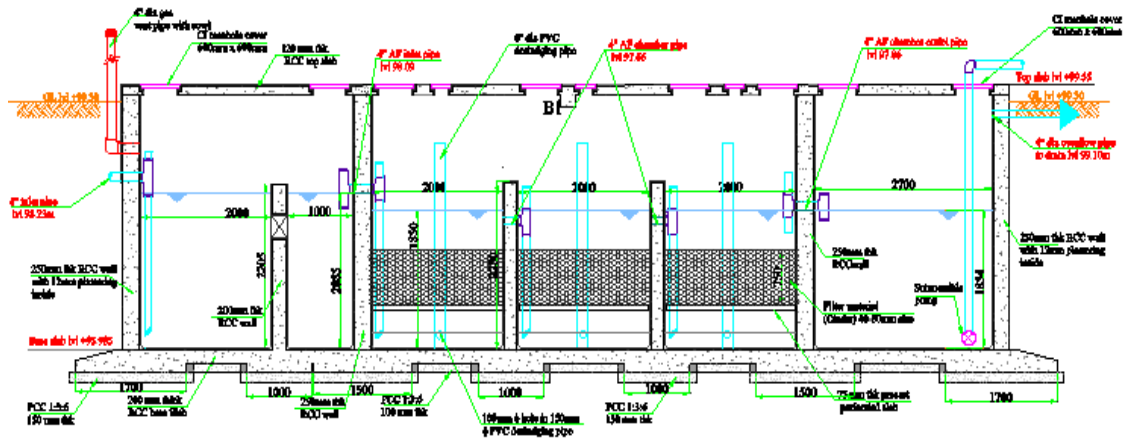
Sl No	Particulars	Unit	Values
1	Discharge (Q daily)	m^3/d	20
2	Time of peak flow (t peak)	hours	4
3	Chemical Oxygen Demand (COD in)	mg/l	1100
4	Biological Oxygen Demand (BOD in)	mg/l	450
5	Min. Temperature (T minimal)	°C	25
6	Type of filter material	Construction Gravel, Cinder or other similar material	

7	Volume of filter material	m^3	17.6
8	Area required	m^2	45

Table 31 Specifications of settler+AF

Parameters	Unit	Values
Faecal sludge quantity	m3	32
Total number of chambers	-	2+3
Hydraulic Retention Time	hrs	36
Area required	m2	62
BOD outlet	mg / L	< 30
COD outlet	mg / L	< 250

Figure 25: 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. 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 and san bed. The bottom slope is 1% and the flow direction is vertical. The main plants used in this filter bed are Canna Indica, Reed juncus, Papyrus and Phragmites. The plant selection is mainly based on their ability to grow in wastewater and have their roots spread wide. The vertical planted drying beds also aid in reducing the nutrients such as N, P and K present in wastewater

Figure 26: Cross section of Vertical Planted Gravel Filter

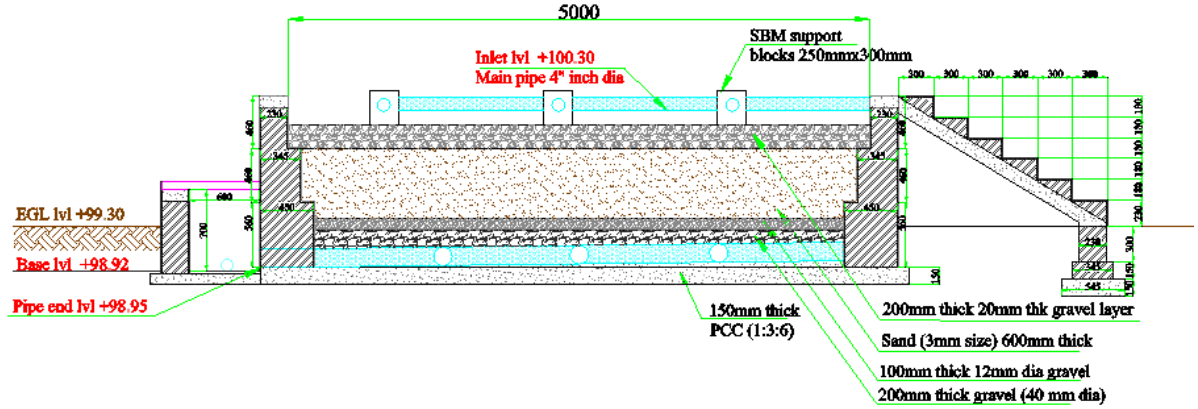


Table 33 Specifications of VPGF

Parameters	Unit	Values
Percolate treatment quantity	m^3	20
Total number of PGF	-	1
Hydraulic Retention Time per PGF	min	1 hour
Area required per PGF	m^2	117.4
BOD outlet	mg / l	<10
COD outlet	mg / l	<50

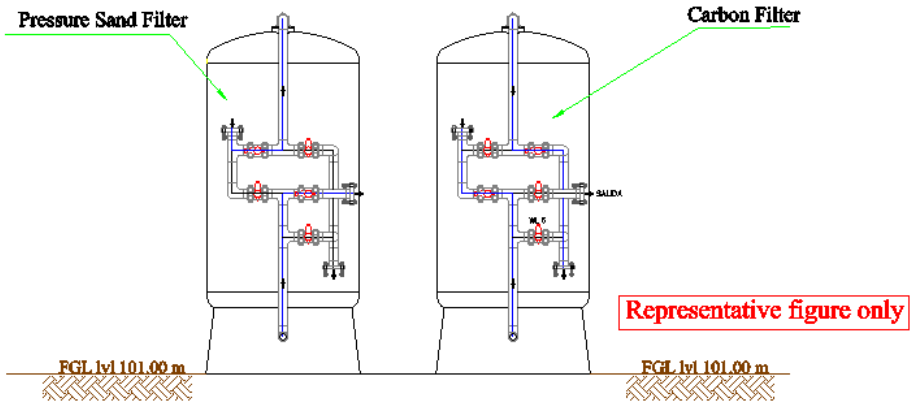
12.6 Post treatment

The treated water from vertical 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 34: 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

Table 35 Costs of Proposed Faecal sludge Treatment Implementation

Abstract costing			
Sl No	**Description**	**Nos**	**Actual cost in INR**
A	**Treatment modules**		
1	Screening chamber	4	₹ 197,830
2	Integrated settler and anaerobic filter	1	₹ 1,325,339
3	Sludge drying bed	4	₹ 18,140,224
	Registers		₹ 307,539
4	Stabilization Tank	2	₹ 3,792,422
5	Vertical Planted Gravel Filter	1	₹ 545,969
6	Collection tank 1	1	₹ 1,469,571
7	Inspection Chamber	2	₹ 117,470
	Total A		**₹ 25,896,364**
B	**Other civil, mechanical and electrical works**		
1	Flexible Pavement		₹ 2,589,252
2	Sludge storage Room		₹ 556,316
3	Operator's room		₹ 375,721
4	Store room		₹ 417,974
5	Generator Room		₹ 43,120
6	Boundary wall		₹ 2,859,758
7	Storm water drain		₹ 504,741
8	Additional works		₹ 737,902
9	Refilling work		₹ 241,095
10	Electrical works		₹ 407,853
11	Tools List		₹ 31,200
	Total B		**₹ 8,764,932**
	Total (A+B)		**₹ 34,661,296**
	Work charge establishment (2%)		₹ 693,226
	GST 18%		₹ 6,239,033
	Grand Total*		**₹ 41,593,555**

14. Estimated Costing For Implementation

Sl no	O&M Costing -Faecal Sludge Treatment Plant, Unnao					
1	**Man power(A)**	**Quantity**	**Rate/ salary**	**Monthly cost**	**Total Cost**	**Total cost/year**
a	Cost Inccured for an Operator	2	12000	24000	288000	288000
b	Cost Inccured for an labours	3	7000	21000	252000	252000
	Sub total(A)				540000	**540000**
2	**Manintenance Activities(B)**	**Frequency**		**Remarks**		
a	Periodic maintenance of pumps(repairs and replacements) for 7 pumps	regular maintenance		0.55% of the total construction cost	190637	190637
b	Sand replacement in SDB	once in a 2 years		based on BOQ	225460	112730
c	Manintenance of integrated settler AF	regular maintenance		0.054% of the total construction cost	18717	18717
d	Replacement of AF filter materials	once in 3 years		0.13% of the total construction cost	45060	15020
e	Replacement of screens in Screening chamber	once in 3 years		based on BOQ	8000	2667
f	Replacement of sand and carbon filter materials in Pressurised sand carbon filter	once in 2 years		based on actuals	50000	25000
g	Replacement of UV lamps	once in 2 years		based on actuals	150000	75000
h	Diesel and other oil for generator and tiller	regular maintenance		see Note 1	612000	612000
i	Regular maintenance for tiller and generator	regular maintenance		0.13% of the total construction cost	45060	45060
j	Replacment of SDB roof sheets	once in 5 years		based on BOQ and quotation	2282944	456589
k	land scaping maintenance	regular maintenance		Lumpsum	30000	30000
l	Mischalaeneous cost			0.27% of the construction cost	93585	93585

	Total (B)				3627878	**1677005**
3	**Power Consumption (C)**	**Total KwH/day**	**rate/ kwh**	**Cost for power consumption /month**	**cost / year**	
a	Power Consumption in entire plant	27	6.5	5265	63180	63180
		Total cost for power consumption/year (C)				**63180**
					GST 18%((A+B+C)x18%)=D	410433
	Total O&M cost(A+B+C+D)					**26,90,618**
Note 1	Consumption of diesel by generator(7.5KvA)- 7 lts/hour; Assuming there is power cut for 3 hours a day; Consumption for a year= 7600 lts. Tiller- consumes atleast 2 lts of diesel per hour; no of running hours: 3 hours/day; consumption in a year= 2200 lts; Change of oil in generator and tiller: 6000/ 3months; 24000/year					

15. Operation and Maintenance of Proposed FSTP System

15.1 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 Unnao 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 36 shows a summary of O&M Steps to be followed. Detailed O&M Activity is given in Annexure 4.

Table 36 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 As and when required As and when required	1. Sludge to be removed from the drying beds as and when they are dry (~ 50% moisture) and used for co-composting 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 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 VPGF 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 37 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 38 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

Table 39 cost of tools

	Costing of tools				
Sl.no.	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
A	Gum boots	Nos	4	1,000.00	4,000.00
B	Plastic drums	Nos	2	500.00	1,000.00
C	Rakes	Nos	3	200.00	600.00
D	Tarpaulin sheet: 9x9 ft size	Nos	6	300.00	1,800.00
E	Broom	Nos	4	50.00	200.00
F	pH meter	Nos	1	700.00	700.00
G	Mask	Nos	5	100.00	500.00
H	Spanner	Nos	1	200.00	200.00
I	Gloves	Nos	4	200.00	800.00
J	First Aid box	Nos	1	400.00	400.00
K	Hose pipe	m	80	35.00	2,800.00
L	Shovel	Nos	2	2,000.00	4,000.00
M	Wheel barrow	Nos	2	5,000.00	10,000.00
O	Plant trimmer	Nos	1	200.00	200.00
P	Sludge measuring device	Nos	1	4,000.00	4,000.00
				Total	**31,200.00**

16. Quality Control during construction of Modules

Table below lists out the teste needed to be done during construction of FSTP Modules. An Implementation Plan is also provided which details out the cinstruction activities with a timeline. Refer Annexure to see these details.

Table 40: List of Tests

Lists of tests		
Sl No	**Description**	**Frequency of the test**
A	**Cement**	Every Batch
i	Initial setting time	
ii	Final Setting Time	
iii	FINENESS BY DRY SEIVING % (90 MICRON)	
iv	COMPRESSIVE STRENGTH N/mm^2 at 3 days, 7 days and 28 days	
B	**Sand**	Every Load
i	Bulkage of sand	
ii	Silt and clay Content	
iii	Specific Gravity	
iv	Sieve Analysis	
C	**Coarse Aggregates**	Every Load
i	Bulk Density-12.5mm	
ii	Bulk Density-20mm	
iii	Specific Gravity-12.5mm	
iv	Specific Gravity-20mm	
v	Sieve Analysis-12.5mm	
vi	Sieve Analysis-20mm	
vii	Impact Value	
viii	Abrasion test	
ix	Flakiness and Elongation index	
D	**Cement Concrete**	Every Concrete Activity
i	Slump Test	
ii	Compressive Strength (7 days and 28 days in N/mm^2	
E	**Cement Concrete Block Test**	
i	Compressive Strength	Every Load
F	**Reinforcement Steel**	**Manufacturers Test Certificate**
G	**uPVC and PVC pipes**	**Manufacturers Test Certificate**
H	**Paver Blocks**	

i	Water absorbtion test	Every Load
ii	Compressive strength test	Every Load
iii	Abrasion Resistance Test	Every Load
iv	Breaking load/ flexural strength	Every Load
I	**Subgrade**	
i	Gradation or sand content	1 test
ii	Standard Proctor test	1 test
iii	Moisture Content	
iv	Density test after rolling	1 test/500 cum
K	**Wet Mix Macadam**	
i	Aggregate impact value	1 test/200 cum of aggregate
ii	Flakiness and Elongation Index	1 test/200 cum of aggregate
iii	Atterberg limit for binding material	1 test/25 cum of binding material
iv	Density of compacted layer	1 test/500 cum
L	**Water quality test for construction**	One time
M	**Water tightness test for structure**	Every Structure
N	**Soil test for foundation**	
i	Density test	all structures

Annexures

Annexure 1

Estimation of faecal sludge currently generated

Residential Survey Data

City Name: Unnao

Population= 1,77,658

Number of Households: 33,273

Average Household size: 5

With a Population Growth of 15.11%

The Population will be= 2,04,502

No of Households =38,300

Data collected in the survey

Total no of Households surveyed: 375. Out of the 375 HHs, 374 were used for calculations

No of HHs having septic tanks: 366

No of HHs having Single Pits: 5

No of HHs having Twin Pits: 3

1. Faecal Sludge Generation- Volume of Containment unit method

Desludging frequency: As per the data, the desludging frequency was selected and the desludging interval was taken as the average of the desludging frequency for calculations

Table 41: Desludging Frequency vs desludging Interval

Desludging Frequency	Desludging interval (yrs)
< 6 months	0.5
1 - 2 years	1.5
2-3 years	2.5
3-4 years	3.5
4-5 years	4.5
5-7 years	6
7-10 years	8.5
> 10 years	10
10-20 years	15

Volume of containment units:

For each type of containment unit (Septic Tank, Single Pit and Twin Pits) the average volumes for each desludging frequency category were calculated.

Table 42: Average Volume of Containment Units

Desludging interval (yrs.)	Average Volume of septic tank(ft^3)	Average Volume of Single Pit (ft^3)	Average Volume of Twin Pit (ft^3)	No of Households having Septic Tank	No of Households having Single Pit	No of Households having Twin Pits
0.5	358.35			2		
1.5	329.59		67.09	28		2
2.5	310.40			17		
3.5	318.54			14		
4.5	308.65			12		
6	492.44			9		
8.5	177.25			5		
10	404.09	21.20		8	1	1
15	300.37	99.89		271	4	

The volumes for septic tanks, single pits and twin pits were calculated using the following formula

a) Total volume of septic tanks= Average Volume of Septic Tanks * No of HHs having septic tanks

b) Total volume of Single Pits= Average Volume of Single Pits * No of HHs having single pits

c) Total volume of Twin Pits= Average Volume of Twin Pits * No of HHs having twin pits

Once the total volume (m3) is calculated, the volume per annum was calculated using this formula

= (Total volume)/ (desludging interval)

The Volume of FS generated is calculated per day.

= (Volume per annum) / 365

Table 43: Calculations for Volume per day

Total Volume- Septic Tank (ft^3)	Total Volume Single Pits (ft^3)	Total Volume- Twin Pits (ft^3)	Total Volume (ft^3)	Total Volume (m^3)	Volume per annum (m^3)	Volume per day (m^3)
716.70	0.00	0.00	716.70	20.29	40.59	0.11
9228.52	0.00	134.18	9362.70	265.12	176.75	0.48
5276.75	0.00	0.00	5276.75	149.42	59.77	0.16
4459.62	0.00	0.00	4459.62	126.28	36.08	0.10
3703.80	0.00	0.00	3703.80	104.88	23.31	0.06
4431.96	0.00	0.00	4431.96	125.50	20.92	0.06
886.25	0.00	0.00	886.25	25.10	2.95	0.01
3232.72	21.20	0.00	3253.92	92.14	9.21	0.03
81400.27	399.56	0.00	81799.83	2316.31	154.42	0.42
					Total	**1.44**

Non-Residential Survey Data

In the data collection process 13 non-residential surveys were included. Due to time constraints and difficulty involved in finding non-residential places which had containment units the 13 samples were obtained. Most of the commercial shops and restaurants did not have toilets with containment units. For the purpose of this project it is assumed that 50 non-residential places in the entire city had containment units

Desludging frequency: As per the data, the desludging frequency was selected and the desludging interval was taken as the average of the desludging frequency for calculations. For containment units that are desludged less than 5 years we have assumed the desludging interval to be 5 years and for the containment units that were desludged after five years the average value of 7.5 years was taken for calculation purposes.

Table 44: Desludging Frequency vs Desludging Interval

Desludging Frequency	Desludging interval (yrs)
< 6 months	0.5
1 year	1
4-5 years	5
5-10 years	7.5
10-20 years	15

Volume of containment units:

All the non-residential units had Septic Tanks and the average volumes for each desludging frequency category were calculated

Table 45: Average Volume of FS

Average Volume of Septic Tanks (ft^3)	No of Households having Septic Tank
1200	1.00
864.00	2.00
1992	1.00
759.6	1.00
622.25	8.00
	13.00

The volumes for septic tanks were calculated using the following formula

a) Total volume of septic tanks= Average Volume of Septic Tanks * No of HHs having septic tanks

Once the total volume (m3) is calculated, the volume per annum was calculated using this formula

= (Total volume)/ (desludging interval)

The Volume of FS generated is calculated per day.

= (Volume per annum) / 365

Table 46: Calculation of Volume of FS per day

Total Volume of Septic tanks (ft^3)	Total Volume (m^3)	Volume per annum (m^3)	Volume per day (m^3)
1200.00	33.98	67.96	0.19
1728.00	48.93	48.93	0.13
1992.00	56.41	11.28	0.03
759.60	21.51	2.87	0.01
4978.00	140.96	9.40	0.03
		Total	**0.38**

Therefore

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

=0.38* 50 / 13

=**1.5 m3 per day**

2. Faecal Sludge Generation- Population Based Method

Taking the above into consideration, we will calculate the Faecal Sludge generated from the area not covered under the Sewerage Scheme. There are 16 Wards (Wards 10,16,18,21,22,2,3,7,9,12,13,17,19,20,26,29) which have not been covered under the Sewerage Scheme

Ward wise Population of the area not covered under Sewerage Scheme (Unnao Nagar Nigam)

Table 47 Ward with population not Included in the sewerage Scheme

Ward number	Ward name	Pop 2011	Pop 2018	Pop 2033
10	Civil line central	6220	6715	7400
16	Kishori khera	5024	5582	6580
18	Civil line kalyani	5837	6011	9170
21	Lokeya khera	7272	7523	10160
22	Daroga bagh	5881	6455	7975
2	Adarsh nagar	7437	7616	8556
3	Shekhpur	5687	10340	15600
7	Jawahar nagar	5065	5098	5520
9	Akrampur	7406	8977	10125
12	Patharkata colony	5463	5508	6883
13	A B nagar south	4872	5113	6161
17	Gandhi nagar	4910	4999	5418
19	Talib saray	7877	8440	10450
20	Hiran nagar	9800	10316	12900
26	A B nagar north	6561	6971	8300
29	Qila	5461	5465	5700
Total		100773	111129	136898
Floating population(5%)		5039	5556	6845
Total population		105811	116685	143742
FS generated		22.22031	24.50385	30.18582

Total Population of Unnao City (Census 2011) = 1,00,773

Design Period of Faecal Sludge Treatment Plant (FSTP) = 15 years

By graphical method the population of Unnao city in 2033= 1,36,898

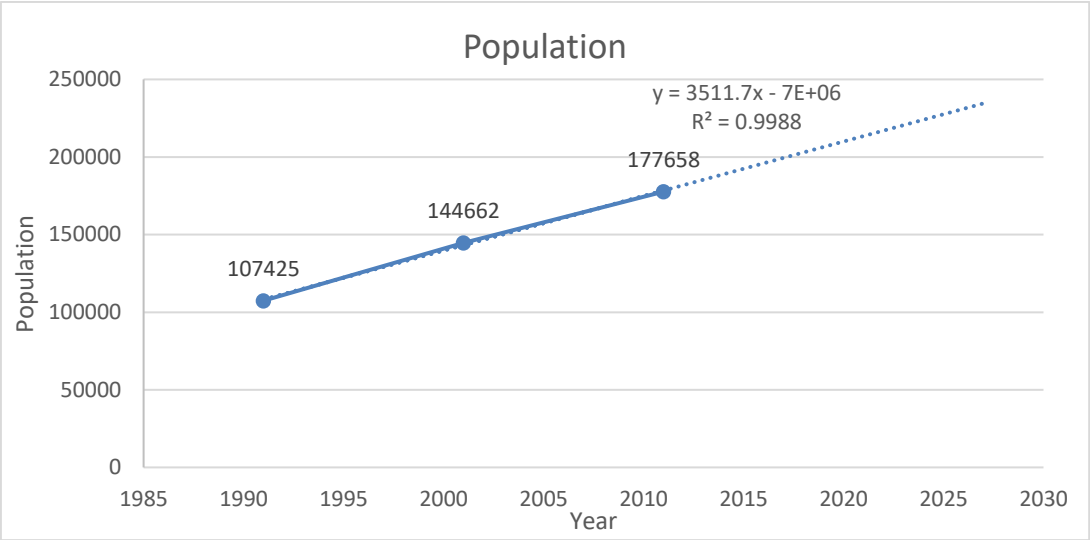


Figure 27: Popoulation Projection for Unnao

Assuming that the remaining 16 zones also grow at the same rate as the total city

The population of the area not covered under Sewer Scheme for 2033 = 1,36,898

Assumption

- Assume 5 % Floating Population of the area not covered under Sewerage Scheme 2033 = 6,845
- By 2 October 2018 the Unnao City will be Open Defecation Free (Swacch Bharat Mission)

Total Population In 2027 of the area not covered under Sewerage Scheme = 1,36,898+ 6,845

= 1,43,742

Sludge Accumulation Rate = .00021m^3/head/day(IS 2470-1(1985))

Total Faecal Sludge Generated in 2033 = Sludge accumulation Rate X Population

=.00021 x 1,43,742 m^3

= 30.18 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

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

For Unnao City as per the survey data if we consider there are two vehicles -3m3 and 4 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 * 2 * 1= **6 m3 per day**

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

   = 4 * 1 * 1= **4 m3 per day**

Annexure 2

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

Table 47 Parameters analysis method

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. Unnao – September 30, 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 48 sample analysis results

Parameters	Feacal Sludge Sample (30/09/2016)
pH	7.5
Alkalinity	10008
Ammonium	<500
Phosphates	240
COD	38650
Total Solids	58163
Volatile Solids	20745

Annexure 3

Techonolgy 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 Phulera Municipality.

Figure 28: 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 7 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

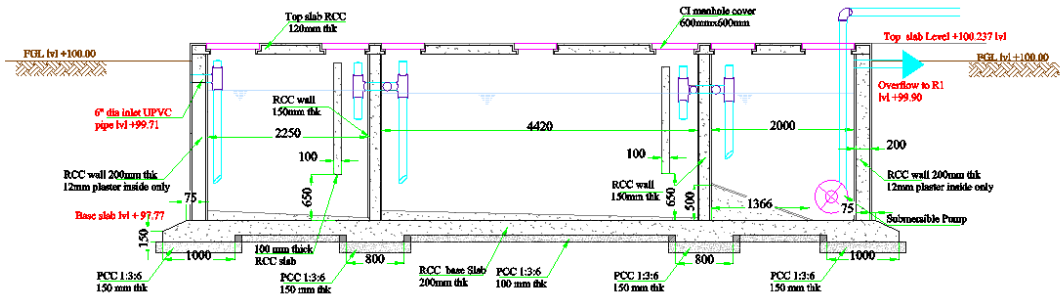


Figure 29: Stabilisation tank

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.

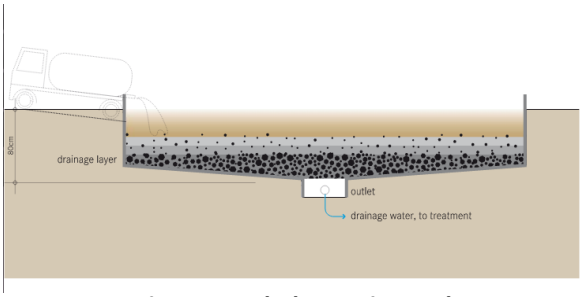


Figure 30: Sludge Drying Beds

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%.

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.


Figure 31: Sludge Drying Beds

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.

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 settle to the bottom of the tank, and scum floats on the surface.

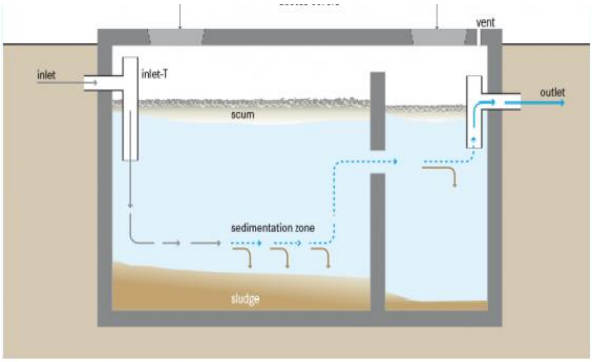


Figure 32: Settler

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 33: Septic Tanks in Ghana

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.

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 - 34.

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.

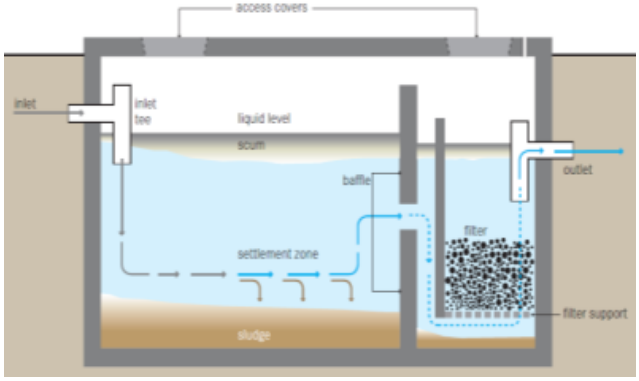


Figure 34: Anaerobic Filter

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.

Figure 35: Anaerobic filter at Tsunami rehabilitation housing colony, India

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.

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 solidss
- 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

Horizontal Planted Gravel Filter

Horizontal planted gravel filter bed is a shallow over-ground open watertight tank filled with graded filter material. HPGF are also known as sub-surface wetland system or root zone treatment system as shown in Figure - 36. HPGF are simple and low maintenance treatment system provided they are well designed and constructed

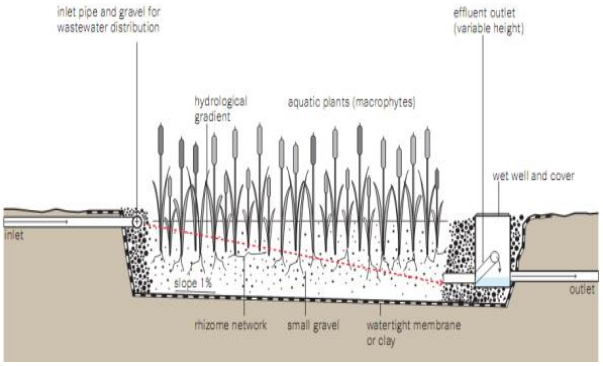


Figure 36: Planted Gravel Filter

Design description: HPGF are suitable for pre-treated domestic wastewater with BOD content less than 100mg/l. Wastewater must be pre-treated especially with respect to suspended solids. The treatment process consists of physical processes of filtration, biological treatment and the intake of oxygen. Generally, the nutrients are removed through adsorption by the plant roots. Pathogens are removed and eliminated through natural die off, UV exposure and adherence. The BOD and COD are reduced through biological aerobic and anaerobic decomposition in the respective layers of filters.

River pebbles or construction gravel are often used as filter material and planted with vegetation like Canna Indica, Colacasia, Reed Juncas and Pappyrus. A good distribution system at the inlet is required to ensure equal distribution of influent across the entire width, which is essential for efficient performance. The filter body is permanently soaked with water and operates partly aerobic in the top layer, partly anoxic in the middle layer and partly anaerobic in the bottom layer. The oxygen required for aerobic degradation is supplied directly from the atmosphere by diffusion or oxygen released from the vegetation roots.

Figure 37: HPGF at IIYW Institute, Lonara, Nagpur, India

The removal efficiency is based on surface area and cross-sectional area available for the flow. The quality of treatment in well-operated HPGF is in the range of 50-60% BOD removal. The enrichment of dissolved oxygen occurs largely in this treatment module

Application: Appropriate at household level and cluster level. Pre-treated wastewater from ABRs, AFs, septic tanks can be further treated. It requires community involvement for proper functioning if applied at cluster level. It is a good option where land is cheap and available.

Operation and maintenance: The flow of wastewater though the treatment unit should always be sub-surface or else algal formation may occur on the surface, which may lead to filter clogging. Filter bed needs regular visual checking for clogging. The filter material needs to be cleaned periodically (every 3-5 years). Trimming of vegetation and cleaning of dead leaf litter is required regularly.

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

Advantages:

- Low operation and maintenance – process stability
- Can be built and repaired with locally available materials and local labourers
- Utilisation of natural processes
- High reduction of BOD, suspended solids and pathogens
- Does not have the mosquito problems of the Free-Water Surface Constructed Wetland
- No electrical energy is required
- Low operating costs
- Does not have the mosquito problems compared to the free-water surface constructed wetland Requires less space

Disadvantages:

- Requires a large land area
- Little nutrient removal
- Risk of clogging, depending on pre- and primary treatment
- Long start-up time to work at full capacity
- Requires expert design and construction supervision
- Not very tolerant to cold climate

Annexure 4

Operations 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 (condom, 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.

2.2 Checking 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 10 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 Phulera ULB 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:

7.1 Inspection 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 ,`
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.

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 Month	6 Month	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				**X**			

	bearings with kerosene							
	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		

Estimates of cost for tools

	Costing of tools				
Sl.no.	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
A	Gum boots	Nos	4	1,000	4,000
B	Plastic drums	Nos	2	500	1,000
C	Rakes	Nos	3	200	600
D	Tarpaulin sheet: 9x9 ft size	Nos	6	300	1,800
E	Broom	Nos	4	50	200
F	pH meter	Nos	1	700	700
G	Mask	Nos	5	100	500
H	Spanner	Nos	1	200	200
I	Gloves	Nos	4	200	800
J	First Aid box	Nos	1	400	400
K	Hose pipe	m	80	35	2,800
L	Shovel	Nos	2	2,000	4,000
M	Wheel barrow	Nos	2	5,000	10,000
O	Plant trimmer	Nos	1	200	200
P	Sludge measuring device	Nos	1	4,000	4,000
				Total	**31,200 ***

Annexure 5

FSTP site report

This document can be used to collect information about proposed sites for faecal sludge treatment plant.

Name of the surveyor: Nithin A.

Date: 19/07/2017

GPS Pin number: 26.5304031, 80.5330719

Location: Chandpur, Unnao

Town/City/District: Unnao

State: Uttar Pradesh

Proposed treatment capacity (m^3 per day): 32

Approach

1. What is the distance between the centre of town/cluster (place around which most household that require desludging services are located) and the proposed site?

   6-8 KM

2. Does the approach road to the site have a width of less than 3 metres? Can the desludging vehicle ply freely on the approach road?

   The width of the road varies from 2 to 3m once road starts from Highway. Due to sharp turns, pot holes on road and movement of villager and cattle, the desludging vehicle movement can be slow.

3. Condition of the approach road
   ☐ Concrete ☒ Tar road ☐ Gravel and mud ☐Stone/gravel

   ☐Others (Please specify)

4. Can the road be used during rains?

   Yes, with little difficulty.

5. Does the approach road lead into the property?
   ☒ Yes ☐ No, it stops at a distance of _____ metres after which there is _____

Property details

1. What is the total area available for construction of FSTP? (also mention the units)

   12,000 sqm

2. Does the property have any other system/ infrastructure? If yes, what is it?) (Check if the manpower can be shared for FSTP operation)

   NO

3. Does the property have a boundary wall? (to prevent trespassers and animals)

   NO

4. What is the distance to nearest habitat (household where people live)?

   500 m

5. What is the terrain of the proposed site?
   ☐ Rocky ☐ Sandy ☐ Mud ☐ Wetland ☐Plantation – manmade

   ☐Plantation natural ☒others, specify clayey hard strata with flat terrain

6. What is the depth of water table?

   More than 30 feet (local intelligence)

7. Is there an open well/ bore well/hand pump/tube well nearby? If yes, at what distance from the property?

   No

8. Is there a natural drain/river/canal/pond nearby? If yes, at what distance from the property?

   Yes, NOON River flows at a distance of 235m, mostly polluted with industrial wastewater.

9. Is portable water available at the property? If yes, what is the source and frequency?

   No.

10. Does the property have access to electricity? If yes, please specify the number of hours in a day it is available and the phase (3 phase or single phase)

    No.

11. Is there a provision for an operator room/house?

    No

12. Is the place located on the lower regions of natural drainage basin? Is the area flood prone?

    Site is on the bank of natural drain, least chances of flooding as per local Information.

13. Details of neighbouring land parcels

Direction	Mention the usage of the land
North	Agricultural land and Noon River
East	Agricultural land
West	Agricultural land and Road
South	Agricultural land and Road

14. Does the land have a natural slope? (if yes please mention in the sketch)

    No

15. Does the land require felling of big trees for FSTP construction?

    No

Reuse

1. Is there a provision for reuse of Biogas? If yes, what and where?

   No

2. Is there a provision for reuse of treated water? If yes, what and where? If no, what are the means for disposal?

   Yes, in the agricultural land around site. Otherwise to be discharge in the Noon River

3. Is there a provision for reuse of bio solids? If yes, what and where? If no, what are the means for disposal?

   Yes, composted solids can be distributed to Farmers

General details

1. Climate details

Climate Information	
Hottest Month	June (33 °C avg)
Coldest Month	January (15 °C avg)
Wettest Month	July (194.7 mm avg)
Windiest Month	June (9 km/h avg)
Annual Rainfall	670.3 mm (per year)
Average Humidity	50%

2. What is the size of desludging truck? (express in M^3 , capacity of sludge holding tank of the truck)

   #2 3500 Litre (Govt); #1 4000(Pvt)

3. Distance between sludge outlet from the truck/vehicle and the ground level? (in M)

   0.6 m

4. Does the site have adequate incidence of sunlight? (check for shadow regions or regions covered under natural/man made cover)

Yes.

5. Is there a solid waste management yard in the vicinity? (If yes, please specify, the type of SWM, distance and quantity handled per day)

   No. But it's only in the proposal. No work started on the solid waste management.

6. Who is the current owner of land? Is any transfer proposed? If yes, to whom and when?

   Unnao Nagar Palika

7. What is the proposed development in the surrounding region for the next 30 years? (Are there any layouts, institutions, etc. planned)

   No such development is expected.

Schematic

In the next page make the following markings along with a detailed sketch of the site

a. Detailed boundary map
b. Topography details on the schematic map (mark slopes)
c. Wind direction
d. Location of other infrastructure (SWM centres, well, tank etc.)
e. Location of ponds, stream, river etc.
f. Location of surrounding human habitation

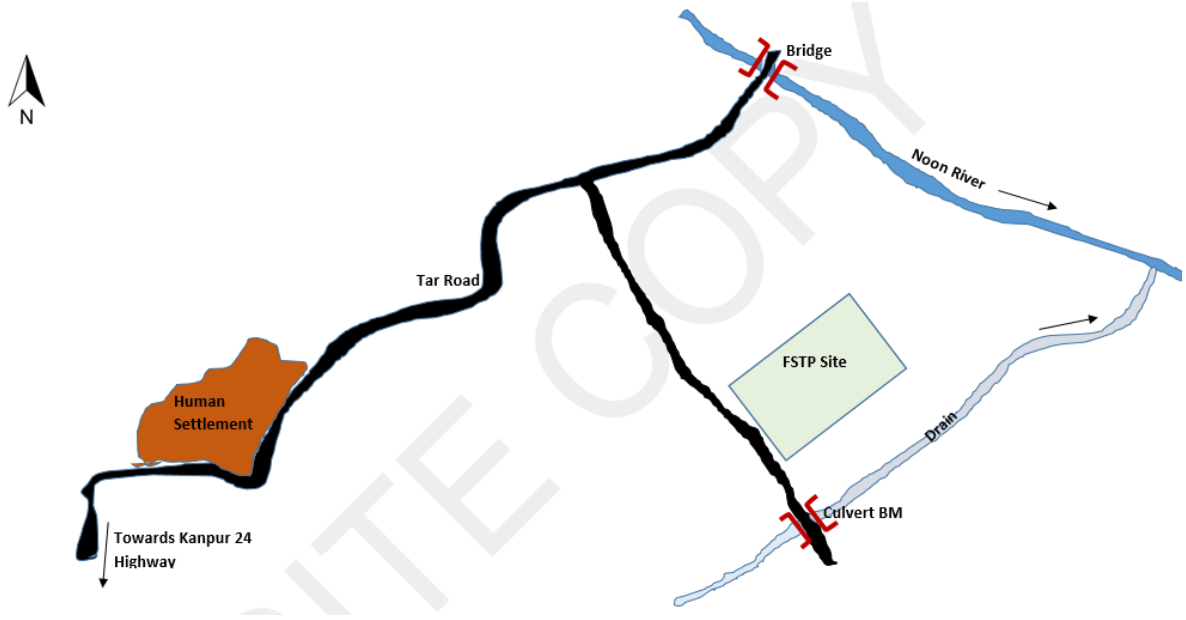


Figure 38: Schematic diagram of FSTP site location

Annexure 6

Estimates of costs for FSTP, Unnao

Abstract sheet of Screening Chamber & grit chamber						
Sl.n	**Item No**	**Description**	**Unit**	**Quantity**	**Rate in Rs.**	**Amount in Rs.**
A		**Earthwork- Excavation**				
a	CPWD Delhi SOR vol - 1, 2016, Code No 2.6(page 76)	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge.				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.6.1(page 76)	In all type of soil	cum	9.89	125.95	₹ 1,246
b		**Refilling with excavated earth**				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.25(page 79)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m	Cum	6.23	125.75	₹ 784
B		**Plain Cement Concrete (P.C.C)**				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1(page 88)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :				
	CPWD Delhi SOR vol - 1, 2016, Code	1:3:6 (1 Cement : 3 coarse sand (zone-III) : 6 graded stone aggregate 20 mm nominal size).	Cum	0.79	4,927.00	₹ 3,912

	No 4.1.5(page 88)					
C		**Reinforced Cement Concrete (R.C.C), M30**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.34.1(page 102)	Providing and laying in position machine batched and machine mixed design mix M-30 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge.“(Note :- Cement content considered in M-30 is @ 340 kg/cum)				
			Cum	1.42	6,515.95	₹ 9,232
D		**Reinforcement**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22(page 100)	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level.				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22.6(page 100)	Thermo-Mechanically Treated bars of grade Fe-500D or more.	kg	0.17	56,600.00	₹ 9,496
E		**Centering/Shuttering**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.90(page 98)	Centering and shuttering including strutting, propping etc. and removal of form for all heights				

a	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.1(page 98)	Foundations, footings, bases of columns, etc. for mass concrete	sqm	0.75	193.95	₹	146
b	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.3(page 98)	Suspended floors, roofs, landings, balconies and access	sqm	8.95	422.30	₹	3,781
c	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.2(page 98)	Walls (any thickness) including attached pilasters, butteresses,	sqm	8.95	378.60	₹	3,390
F		**BRICK WORK**					
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1031,(page 2)	1ST CLASS BRICK-WORK IN 1:4 CEMENT & LOCAL-SAND MORTAR IN FOUNDATION & PLINTH	cum	1.20	6,400.95	₹	7,678
G		**Plastering with mortar, 1:4**					
	CPWD Delhi SOR vol - 2, 2016, Code No 13.3(page 227)	Cement plastering including T&P, scaffolding, material and complete labpour, including cost of water, curing, racking of joints etc. with 20 mm cement plaster of mix :					
	CPWD Delhi SOR vol - 2, 2016, Code No 13.3.1(page 227)	1:4 (1 cement: 4 fine sand)					
		Total plastering	Sqm	25.34	220.60	₹	5,590
H		**Manhole**					

	Trichy rate	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				
b			Nos	1.00	2,000.00	₹ 2,000
		TOTAL J				
I		**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.)				
a	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia UPVC inlet	RMT	0.50	135.00	₹ 68
	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia UPVC outlet	RMT	0.50	135.00	₹ 68
	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia grit removal pipe	Rmt	0.50	135.00	₹ 68
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 2.5 cms and dimensions of 700 mm x 600 mm	Nos.	1.00	2,000.00	₹ 2,000
		Total for 1 scree chamber and grit chamber				₹ 49,458
		Total for 4 screen chamber				**₹ 197,830.34**

		Abstract sheet of Stabilization Tank				
Sl.n	**Item No**	**Description**	**Unit**	**Quantity**	**Rate in Rs**	**Amount in Rs.**
					rupees	rupees
A		**Rate for Earthwork- Excavation**				
a	CPWD Delhi SOR vol - 1, 2016, Code No 2.6(page 76)	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge.				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.6.1(page 76)	In all type of soil	cum	215.04	125.95	27,084
b		Refilling with excavated earth				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.25(page 79)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m	cum	77.57	125.75	9,754
B		**Plain Cement Concrete (P.C.C)**				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1(page 88)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1.5(page 88)	1:3:6 (1 Cement : 3 coarse sand (zone-III) : 6 graded stone aggregate 20 mm nominal size).				
		Total	Cum	14.38	4,927.00	70,839

C		**Reinforced Cement Concrete (R.C.C), M30**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.34.1(page 102)	Providing and laying in position machine batched and machine mixed design mix M-30 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge."(Note :- Cement content considered in M-30 is @ 340 kg/cum)	cum	49.25	6,515.95	320,939
D		**Reinforcement**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22(page 100)	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level.				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22.6(page 100)	Thermo-Mechanically Treated bars of grade Fe-500D or more.				
		TOTAL	MT	3.7	56,600.00	212,033
E		**Centering/ Shuttering**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.90(page 98)	Centering and shuttering including strutting, propping etc. and removal of form for all heights				
	CPWD Delhi SOR vol - 1,	Foundations, footings, bases of columns, etc. for mass concrete	sqm	119.12	193.95	23,103

	2016, Code No 5.9.1(page 98)					
	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.3(page 98)	Suspended floors, roofs, landings, balconies and access	sqm	57.00	422.30	24,071
	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.2(page 98)	Walls (any thickness) including attached pilasters, butteresses,	sqm	275.01	378.60	104,120
	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.5(page 98)	Lintels, beams, plinth beams, girders, bressumers and cantilevers	sqm	4.66	342.90	1,599
F		**Plastering with mortar, 1:4**				
a	CPWD Delhi SOR vol - 2, 2016, Code No 13.3(page 227)	Cement plastering including T&P, scaffolding, material and complete labpour, including cost of water, curing, racking of joints etc. with 20 mm cement plaster of mix :				
	CPWD Delhi SOR vol - 2, 2016, Code No 13.3.1(page 227)	1:4 (1 cement: 4 fine sand)	sqm	369.87	220.60	81,593
G		**MANHOLES**				

		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	18.00	2,000.00	36,000
H		**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.)				-
	CPWD Delhi SOR vol - 1, 2016, Code No 7197(page 35)	4 inch dia inlet	Rmt	0.60	135.00	81
i	CPWD Delhi SOR vol - 1, 2016, Code No 7197(page 35)	4 inch dia inlet vertical	Rmt	1.70	135.00	230
ii	CPWD Delhi SOR vol - 1, 2016, Code No 7197(page 35)	4 inch dia pipe horizontal	RMT	24.00	135.00	3,240
iii	CPWD Delhi SOR vol - 1, 2016,	4 inch dia pipe vertical	Nos	13.68	135.00	1,847

	Code No 7197(page 35)					
iv	CPWD Delhi SOR vol - 1, 2016, Code No 7209(page 35)	4 inch bend	Nos	6.00	62.00	372
	CPWD Delhi SOR vol - 1, 2016, Code No 7197(page 35)	4 inch TEE	Nos	20.00	85.00	1,700
I		**Submersible pump**				
	Non scheduled item (Rajasthan Rate)	Submersible wastewaterpump @3cum/hr, 5 m head, 1.1 HP single phase	Nos	1.00	29,500.00	29,500
		Total				**948,105**
		Total for 4 Stabilisation tank				**3,792,421.60**

		Astract sheet of Sludge Drying Bed				
Sl.n		**Description**	**Unit**	**Quantity**	**Rate in Rs**	**Amount in Rs**
A		**Rate for Earthwork- Excavation**				
a	CPWD Delhi SOR vol - 1, 2016, Code No 2.6(page 76)	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge.				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.6.1(page 76)	In all type of soil	cum	189.36	125.95	₹ 23,849
b		Refilling with excavated earth				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.25(page 79)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m	cum	12.35	125.75	₹ 1,552
B		**Plain Cement Concrete (P.C.C)**				
1	CPWD Delhi SOR vol - 1, 2016, Code No 4.1(page 88)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1.5(page 88)	1:3:6 (1 Cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size).	cum	139.58	4,927.00	₹ 687,707
	CPWD Delhi SOR vol - 1, 2016, Code	1:2:4 (1 cement : 2 coarse sand (zone-III) : 4 graded stone aggregate 20 mm nominal size).	Cum	6.04	5,481.95	₹ 33,091

	No 4.1.3(page 88)						
C		**Rubble Soling**					
	Trichy Rate	**Supplying and filling 40mm down size aggregartes along with watering and ramming as specified by EIC**	cum	179.22	2,200.00	₹	394,281
D	CPWD Delhi SOR vol - 1, 2016, Code No 0362(page 8)	**Brick Bat Filling**					
			cum	54.29	500.00	₹	27,147
E		**Reinforced Cement Concrete (R.C.C), M30**					
	CPWD Delhi SOR vol - 1, 2016, Code No 5.34.1(page 102)	Providing and laying in position machine batched and machine mixed design mix M-30 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge.“(Note :- Cement content considered in M-30 is @ 340 kg/cum)	cum	7.12	6,515.95	₹	46,403
F		**Reinforcement**					
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22(page 100)	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level.					
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22.6(page 100)	Total	MT	1.37	56,600.00	₹	77,295

G		**Centering/Shuttering**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.90(page 98)	Centering and shuttering including strutting, propping etc. and removal of form for all heights				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.3(page 98)	Suspended floors, roofs, landings, balconies and access	sqm	16.43	422.30	₹ 6,939
	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.6(page 98)	Columns, Pillars, Piers, Abutments, Posts and Struts	sqm	99.36	467.85	₹ 46,486
H		**BRICK WORK**				
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1031,(page 2)	1st class brick-work in 1:4 cement & local-sand mortar in foundation & plinth				
		Total	cum	129.95	6,400.95	₹ 831,809
I		**Plastering 1:4**				
	CPWD Delhi SOR vol - 2, 2016, Code No 13.1(page 227)	Cement plastering including T&P, scaffolding, material and complete labpour, including cost of water, curing, racking of joints etc. with 12 mm cement plaster of mix :				
	CPWD Delhi SOR vol - 2, 2016, Code No 13.1(page 227)	1:4 (1 cement: 4 fine sand)	sqm	1,309.66	172.95	₹ 226,506

J		**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.)					
		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	120.00	135.00	₹	16,200
	CPWD Delhi SOR vol - 1, 2016, Code No 7197(page 35)	110mm dia registar outlet	RMT	3.60	135.00	₹	486
	CPWD Delhi SOR vol - 1, 2016, Code No 7197(page 35)	110mm dia Registar inlet from SR	RMT	14.00	135.00	₹	1,890
	CPWD Delhi SOR vol - 1, 2016, Code No 7197(page 35)	110mm dia interconnecting registar pipes	RMT	50.05	135.00	₹	6,757
	CPWD Delhi SOR vol - 1, 2016, Code No 7197(page 35)	110mm dia Registar outlet to IC1	RMT	8.24	135.00	₹	1,112
		Supply & fixing of SS pipe with clamps, tees and fixtures	RMT	72.13	1,600.00	₹	115,408
		75mm dia distribution pipe SS pipe	RMT	97.44	1,600.00	₹	155,904
		75mm dia inlet pipe SS pipe	RMT	21.60	1,600.00	₹	34,560

K		**Providing and laying of coarse aggregate size as below after washing & sieving to make it free from fines & dust.**				
i	CPWD Delhi SOR vol - 1, 2016, Code No 0293(page 7)	Aggregates 40mm	Cum	89.62	1,250.00	₹ 112,031
ii	CPWD Delhi SOR vol - 1, 2016, Code No 0296(page 8)	Aggregates 12 mm to 16 mm	Cum	71.70	1,300.00	₹ 93,210
iii	CPWD Delhi SOR vol - 1, 2016, Code No 0298(page 8)	Aggregates 6mm to 8mm	Cum	48.59	1,300.00	₹ 63,167
iv	PW,P&IWTD, NE zone, kalburgi SR 2016-17(code 0311 page I)	Hollow blocks(400X200X200mm)	Nos	1,344.00	43.00	₹ 57,792
	CPWD Delhi SOR vol - 1, 2016, Code No 0983(page 15)	Sand between hollow blocks	cum	74.52	760.00	₹ 56,635
L		**Sludge Drying Bed Roof**				
a	CPWD Delhi SOR vol - 1, 2016, Code No 10.20(page 182)	Structural steel work riveted, bolted or welded in built up sections, trusses and framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer all complete.	kg	11,185.45	67.60	₹ 756,136
b	CPWD Delhi SOR vol - 1, 2016, Code No 12.47.2(page 745)	Providing & fixing UV stabilised fiberglass reinforced plastic sheet roofing up to any pitch, including fixing with polymer coated 'J' or 'L' hooks, bolts & nuts 8mm dia. G.I plain/bitumen washers complete but excluding the cost of purlins, rafters, trusses etc. The sheets shall be manufactured out of 2400 TEX panel rovigs incorporating minimum 0.3% ultra-violet stabiliser in resin system	sqm	645.92	883.60	₹ 570,736

		under approximately 2400 psi and hot cured. They shall be of uniform pigmentation and thickness without air pockets and shall conform to IS 10192 and IS 12866.The sheets shall be opaque or translucent, clear or pigmented, textured or smooth as specified.				
M		**Rainwater collection system**				
	CPWD Delhi SOR vol - 1, 2016, Code No 12.7(page 702)	Providing and fixing 15 cm wide, 45 cm overall semi-circular plain G.S. sheet gutter with iron brackets 40x3mm size, bolts, nuts and washers etc., including making necessary connections with rain water pipes complete.				
		0.80 mm thick with zinc coating not less than 275 gm/m²	m	130.66	564.70	₹ 73,784
	CPWD Delhi SOR vol - 1, 2016, Code No 12.41.2(page 735)	Providing and fixing on wall face unplasticised Rigid PVC rain water pipes conforming to IS : 13592 Type A, including jointing with seal ring conforming to IS : 5382, leaving 10 mm gap for thermal expansion, (i) Single socketed pipes.				
		110mm dia	m	59.34	236.35	₹ 14,025
	CPWD Delhi SOR vol - 1, 2016, Code No 12.42.1.2(page 736)	coupler 110mm	each	10.00	102.65	₹ 1,027
	CPWD Delhi SOR vol - 1, 2016, Code No 12.42.5.2(page 739)	bend 110mm	each	10.00	113.1	₹ 1,131
		Total for one series of SDB				**₹ 4,535,056**
		TOTAL 4 series of SDB				**₹ 18,140,223.77**

		Astract sheet of Registars 1-12				
Sl.no.		**Description**	**Unit**	**Quantity**	**Rate in Rs**	**Amount in Rs**
A		**Rate for Earthwork- Excavation**				
a	CPWD Delhi SOR vol - 1, 2016, Code No 2.6(page 76)	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge.				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.6.1(page 76)	In all type of soil	cum	13.58	125.95	₹ 1,710
b		Refilling with excavated earth				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.25(page 79)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m	cum	6.34	125.75	₹ 798
B		**Plain Cement Concrete (P.C.C)**				
1	CPWD Delhi SOR vol - 1, 2016, Code No 4.1(page 88)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1.5(page 88)	1:3:6 (1 Cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size).	cum	4.00	4,927.00	₹ 19,708
C		**Reinforced Cement Concrete (R.C.C), M30**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.34.1(page 102)	Providing and laying in position machine batched and machine mixed design mix M-30 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in	cum	1.56	6,515.95	₹ 10,150

		recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge.“(Note :- Cement content considered in M-30 is @ 340 kg/cum)				
D		**Reinforcement**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22(page 100)	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level.				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22.6(page 100)	Total	MT	0.06	56,600.00	₹ 3,586
E		**Centering/Shuttering**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.90(page 98)	Centering and shuttering including strutting, propping etc. and removal of form for all heights				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.3(page 98)	Suspended floors, roofs, landings, balconies and access	sqm	25.51	422.30	₹ 10,773
F		**BRICK WORK**				
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1031,(page 2)	1ST CLASS BRICK-WORK IN 1:4 CEMENT & LOCAL-SAND MORTAR IN FOUNDATION & PLINTH				
		Total	cum	13.22	6,400.95	₹ 84,647
G		**Plastering 1:4**				
	CPWD Delhi SOR vol - 2, 2016,	Cement plastering including T&P, scaffolding, material and complete labpour, including cost of water, curing, racking of joints etc. with 12 mm cement plaster of mix :				

	Code No 13.1(page 227)					
	CPWD Delhi SOR vol - 2, 2016, Code No 13.1(page 227)	1:4 (1 cement: 4 fine sand)	sqm	129.50	172.95	₹ 22,397
						₹ 153,770
		TOTAL 2 set of Registars				**₹ 307,539.40**

		Abstarct sheet of Integrated Settler and AF + Collection tank				
Sl.n	**Item No**	**Description**	**Unit**	**Quantity**	**Rate in Rs.**	**Amount in Rs.**
A		**Rate for Earthwork- Excavation**				
a	CPWD Delhi SOR vol - 1, 2016, Code No 2.6(page 76)	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge.				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.6.1(page 76)	In all type of soil	cum	419.95	125.95	₹ 52,893
b		Refilling with excavated earth				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.25(page 79)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m	cum	183.32	125.75	₹ 23,053
B		**Plain Cement Concrete (P.C.C), 1:3:6**				
1	CPWD Delhi SOR vol - 1, 2016, Code No 4.1(page 88)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1.5(page 88)	1:3:6 (1 Cement : 3 coarse sand (zone-III) : 6 graded stone aggregate 20 mm nominal size).				
		TOTAL B	Cum	13.31	4,927.00	₹ 65,555
C		**Reinforced Cement Concrete (R.C.C), M30**				
1	CPWD Delhi SOR vol - 1, 2016,	Providing and laying in position machine batched and machine mixed design mix M-30 grade cement concrete				

	Code No 5.34.1(page 102)	for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge."(Note :- Cement content considered in M-30 is @ 340 kg/cum)				
		Total for RCC	Cum	64.62	6,515.95	₹ 421,059
D		**Reinforcement**				
1	CPWD Delhi SOR vol - 1, 2016, Code No 5.22(page 100)	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level.				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22.6(page 100)	Thermo-Mechanically Treated bars of grade Fe-500D or more.				
		Total for reinforcement	KG	6,664.7		
			MT	6.7	56,600.0	₹ 377,223
E		**Centering/ Shuttering**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.90(page 98)	Centering and shuttering including strutting, propping etc. and removal of form for all heights				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.1(page 98)	Foundations, footings, bases of columns, etc. for mass concrete	sqm	71.28	193.95	₹ 13,825
	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.2(page 98)	Walls (any thickness) including attached pilasters, butteresses,	sqm	360.30	378.60	₹ 136,411

	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.2(page 98)	Suspended floors, roofs, landings, balconies and access	sqm	50.33	422.30	₹ 21,256
	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.5(page 98)	Lintels, beams, plinth beams, girders, bressumers and cantilevers	sqm	7.98	342.90	₹ 2,736
F		**Plastering with mortar, 1:4**				
a	CPWD Delhi SOR vol - 2, 2016, Code No 13.3(page 227)	Cement plastering including T&P, scaffolding, material and complete labpour, including cost of water, curing, racking of joints etc. with 20 mm cement plaster of mix :				
	CPWD Delhi SOR vol - 2, 2016, Code No 13.3.1(page 227)	1:4 (1 cement: 4 fine sand)	Sqm	378.13	220.60	₹ 83,416
G		**Manholes**				
		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	14	2,000	₹ 28,000
			Nos	14	2,000	₹ 28,000
H		**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.)				
a	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110 mm dia UPVC inlet to settler horizontal	Rmt	0.52	135.00	₹ 70
b	CPWD Delhi SOR vol - 1, 2016, Code No 7197(page 35)	110 mm dia Tees fixing to inlet	Nos	1.00	85.00	₹ 85
c	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110 mm dia UPVC inlet to settler vertical	Rmt	2.50	135.00	₹ 338
d	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia AF inlet horizontal	Rmt	2.80	135.00	₹ 378
e	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia AF inlet vertical	Rmt	20.00	135.00	₹ 2,700
f	CPWD Delhi SOR vol - 1, 2016, Code No 7197(page 35)	110mm dia Tee fixing to AF inlet	Nos	16.00	85.00	₹ 1,360
g	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia AF chamber pipe horizontal	Rmt	5.60	135.00	₹ 756

h	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia AF chamber pipe vertical	Rmt	33.60	135.00	₹ 4,536
i	CPWD Delhi SOR vol - 1, 2016, Code No 7197(page 35)	110mm dia Tee fixing to AF chamber pipe	Nos	32.00	85.00	₹ 2,720
j	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia AF outlet pipe horizontal	Rmt	2.80	135.00	₹ 378
k	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia AF outlet pipe vertical	Rmt	6.40	135.00	₹ 864
l	CPWD Delhi SOR vol - 1, 2016, Code No 7197(page 35)	110mm dia Tee fixing to AF outlet pipe	Nos	16.00	85.00	₹ 1,360
m	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia vent pipe	Rmt	2.00	135.00	₹ 270
n	CPWD Delhi SOR vol - 1, 2016, Code No 7209(page 35)	Elbow to vent pipe	Nos	1.00	62.00	₹ 62
o		160mm dia desludging pipe	Rmt	16.59	135.00	₹ 2,240
	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia overflow pipe & CT outlet	Rmt	0.70	135.00	₹ 95
	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia pipe at submersible pump	Rmt	4.22	135.00	₹ 570

	CPWD Delhi SOR vol - 1, 2016, Code No 7209(page 35)	Elbow	Nos	1.00	62.00	₹ 62
I		**Filter material for Anaerobic Filter**				
	CPWD Delhi SOR vol - 1, 2016, Code No 0293(page 7)	Providing and laying aggregates as a Filter Material In AF as per the instruction given by the site engineer in charge.				
		Aggregates 40-80mm	Cum	18.86	1,250.00	₹ 23,569
J		**Submersible pump**				
		Submersible wastewaterpump @3cum/hr, 5 m head, 1.1 HP single phase	Nos	1.00	29,500.00	₹ 29,500
		Total				**1,325,339**

Abstract sheet of Vertical Planted Gravel Filter						
Sl.n	**Item No**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
A		**Rate for Earthwork- Excavation**				
a	CPWD Delhi SOR vol - 1, 2016, Code No 2.6(page 76)	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge.				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.6.1(page 76)	In all type of soil	Cum	76.26	125.95	₹ 9,604
		Refilling with excavated earth				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.25(page 79)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m	Cum	15.96	125.75	₹ 2,007
B		**Plain Cement Concrete (P.C.C), 1:3:6**				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1(page 88)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1.5(page 88)	1:3:6 (1 Cement : 3 coarse sand (zone-III) : 6 graded stone aggregate 20 mm nominal size).	cum	27.59	4,927.00	₹ 135,952
C		**Reinforced Cement Concrete (R.C.C), M30**				
	CPWD Delhi SOR vol - 1, 2016,	Providing and laying in position machine batched and machine mixed design mix M-30 grade cement concrete for reinforced cement concrete work, using cement content as	cum	0.71	6,515.95	₹ 4,617

	Code No 5.34.1(page 102)	per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge."(Note :- Cement content considered in M-30 is @ 340 kg/cum)				
D		**Reinforcement**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22(page 100)	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level.				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22.6(page 100)	Thermo-Mechanically Treated bars of grade Fe-500D or more.	MT	0.01	56600.00	₹ 794
E		**Brick work**				
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1031,(page 2)	1ST CLASS BRICK-WORK IN 1:4 CEMENT & LOCAL-SAND MORTAR IN FOUNDATION & PLINTH				
		TOTAL	cum	29.04	6,400.95	₹ 185,895
F		**Plastering with mortar, 1:4**				
	CPWD Delhi SOR vol - 2, 2016,	Cement plastering including T&P, scaffolding, material and complete labpour, including cost of water, curing, racking of joints etc. with 20 mm cement plaster of mix :				

	Code No 13.3(page 227)					
	CPWD Delhi SOR vol - 2, 2016, Code No 13.3.1(page 227)	**1:4 (1 cement: 4 fine sand)**	Sqm	184.26	220.60	₹ 40,648
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.)				
	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110 mm dia and 8 mm perforations at 60^{o} and 105^{o} every 30 centimeter.	Rmt	55.20	135.00	₹ 7,452
	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110 mm dia pipe	Rmt	10.00	135.00	₹ 1,350
	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia, sampling pipes fixing	Rmt	17.40	135.00	₹ 2,349
	CPWD Delhi SOR vol - 1, 2016,	Swivel pipes 4'' dia	Rmt	3.14	135.00	₹ 424

	Code No 7189(page 35)					
	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110 mm dia and 10 mm perforations at 60o and 105o and 0o , 90o and 270o alternatively every 15 centimeter.	Rmt	58.80	135.00	₹ 7,938
	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110 mm diaand 8mm perforated pipe	Rmt	10.00	135.00	₹ 1,350
	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110 mm dia VPGF outlet to CT	Rmt	3.10	135.00	₹ 419
	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia registar interconnecting pipe	Rmt	9.40	135.00	₹ 1,269
	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia registar to IC3 interconnecting pipe	Rmt	5.70	135.00	₹ 770
	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia pipe from ISAF to VPGF	Rmt	16.71	135.00	₹ 2,256
G		**Filter material**				
		Providing and laying of coarse aggregate size as below after washing & sieving to make it free from fines & dust.				

i	CPWD Delhi SOR vol - 1, 2016, Code No 0293(page 7)	Aggregates 40mm	cum	22.09	1,250.00	₹ 27,608
ii	CPWD Delhi SOR vol - 1, 2016, Code No 0296(page 8)	Aggregates 12mm	cum	8.84	1,300.00	₹ 11,490
	CPWD Delhi SOR vol - 1, 2016, Code No 0982(page 8)	Sand 3mm	cum	54.81	1200.00	₹ 65,777
H	CPWD Delhi SOR vol - 1, 2016, Code No 0295(page 8)	Aggregates 20mm	cum	20.00	1300.00	₹ 26,000
I		**Plants**				
	Quotation	Providing and planting common reeds or other rhizome with two plant per square metre	nos	400.00	25.000	₹ 10,000
					Total	**₹ 545,969**

Abstract sheet of Collection Tank 1						
Sl.n	**Item No**	**Description**	**Unit**	**Quantity**	**Rate in Rs.**	**Amount in Rs.**
A		**Rate for Earthwork- Excavation**				
a	CPWD Delhi SOR vol - 1, 2016, Code No 2.6(page 76)	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge.				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.6.1(page 76)	In all type of soil				
		Total	cum	191.63	125.95	₹ 24,136
b		Refilling with excavated earth				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.25(page 79)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m	cum	71.09	125.75	₹ 8,939
B		**Plain Cement Concrete (P.C.C), 1:3:6**				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1(page 88)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1.5(page 88)	1:3:6 (1 Cement : 3 coarse sand (zone-III) : 6 graded stone aggregate 20 mm nominal size).				
		TOTAL B	cum	9.81	4,927.00	₹ 48,311
C		**Reinforced Cement Concrete (R.C.C), M30**				

	CPWD Delhi SOR vol - 1, 2016, Code No 5.34.1(page 102)	Providing and laying in position machine batched and machine mixed design mix M-30 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge.“(Note :- Cement content considered in M-30 is @ 340 kg/cum)				
		TOTAL	Cum	34.57	6,515.95	₹ 225,231
D		**Reinforcement**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22(page 100)	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level.				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22.6(page 100)	Thermo-Mechanically Treated bars of grade Fe-500D or more.				
		Total Reinforcement	MT	3.35	56,600.00	₹ 189,744
E		**Centering/ Shuttering**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.90(page 98)	Centring and shuttering with plywood or steel sheet upto two stories or height upto 7.5 metre above plinth level including strutting, propping etc. and removal of form for :				
a	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.1(page 98)	Foundations, footings, bases of columns, etc. for mass concrete	sqm	83.69	193.95	₹ 16,232

b	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.2(page 98)	Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc	sqm	185.32	378.60	₹	70,163
c	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.3(page 98)	Suspended floors, roofs, landings, balconies and access platform	sqm	41.93	422.30	₹	17,707
F		**Plastering with mortar, 1:4**					
a	CPWD Delhi SOR vol - 2, 2016, Code No 13.1(page 227)	Cement plastering including T&P, scaffolding, material and complete labpour, including cost of water, curing, racking of joints etc. with 12 mm cement plaster of mix :					
	CPWD Delhi SOR vol - 2, 2016, Code No 13.1.1(page 227)	1:4 (1 cement: 4 fine sand)	sqm	199.07	172.95	₹	34,429
G		**Manhole Covers**					
		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	6.00	2,000.00	₹	12,000
H		**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	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110 mm dia UPVC inlet pipes	Rmt	1.50	135.00	₹ 203
ii	CPWD Delhi SOR vol - 1, 2016, Code No 7197(page 35)	110 mm dia PVC-Tees	Nos	4.00	85.00	₹ 340
	CPWD Delhi SOR vol - 1, 2016, Code No 7189(page 35)	110mm dia UPVC outlet pipe	Rmt	0.50	135.00	₹ 68
I		**Submersible pump**				
		Submersible pump @3cum/hr, 5 m head, 1.1 HP single phase	Nos	2.00	29,500.00	₹ 59,000
J		**valves**				
		3 ball valves at inlet , outlet and at over flow pipes of 110mm dia	Nos	3.00	500.00	₹ 1,500
K		**Supply, installation and commissioning of FRP sand carbon filter with loaded graded material**	Nos	1.00	300,000.00	₹ 300,000
		Provide sand and carbon along with neccesary accessories such as pumps, multiport values and piping. To include all installtions, testing and commissioning of				

		the set up. Description of the item as mentioned in bid document				
L		**Supply, installation and commissioing of UV treatment unit - Description as specified in bid document**	Nos	1.00	320,000.00	₹ 320,000
		Roof for sand carbon filter				
	RUIDP SOR 2017 (29.2)	Structural steel work riveted, bolted or welded in built up sections, trusses and framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer all complete:	MT	1.50	74,900.00	₹ 112,350
	RUIDP SOR 2017 (31.1.1 (page 201)	Providing corrugated G.S. sheet roofing including vertical/ curved surface fixed with polymer coated J or L hooks, bolts and nuts 8 mm diameter with bitumen and G.I. limpet washers or with G.I. limpet washers filled with white lead and including a coat of approved steel primer and two coats of approved paint on overlapping of sheets complete upto any pitch in horizontal/ vertical or curved surfaces) excluding the cost of purlins, rafters and trusses and including cutting to size and shape wherever required.	sqm	30.00	974.00	₹ 29,220
		Total				**₹ 1,469,571**

Abstract sheet of Inspection chamber 1,2,3						
Sl.n	**Item No**	**Description**	**Unit**	**Qty**	**Rate in Rs.**	**Amount in Rs.**
A		**Rate for Earthwork- Excavation**				
a	CPWD Delhi SOR vol - 1, 2016, Code No 2.6(page 76)	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge.				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.6.1(page 76)	In all type of soil				
		Total	cum	44.63	125.95	₹ 5,621
b		Refilling with excavated earth				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.25(page 79)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m	cum	30.57	125.75	₹ 3,844
B		**Plain Cement Concrete (P.C.C), 1:3:6**				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1(page 88)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1.5(page 88)	1:3:6 (1 Cement : 3 coarse sand (zone-III) : 6 graded stone aggregate 20 mm nominal size).				
		TOTAL B	cum	2.98	4,927.00	₹ 14,698
C		**Reinforced Cement Concrete (R.C.C), M30**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.34.1(page 102)	Providing and laying in position machine batched and machine mixed design mix M-30 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and	cum	0.79	6,515.95	₹ 5,158

		durability as per direction of Engineer-in-charge."(Note :- Cement content considered in M-30 is @ 340 kg/cum)				
D		**Reinforcement**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22(page 100)	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level.				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22.6(page 100)	Thermo-Mechanically Treated bars of grade Fe-500D or more.	MT	0.10	56,600.00	₹ 5,601
E		**Centering/ Shuttering**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.90(page 98)	Centring and shuttering with plywood or steel sheet upto two stories or height upto 7.5 metre above plinth level including strutting, propping etc. and removal of form for :				
a	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.1(page 98)	Foundations, footings, bases of columns, etc. for mass concrete	sqm	5.92	193.95	₹ 1,148
b	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.3(page 98)	Suspended floors, roofs, landings, balconies and access platform	sqm	12.72	422.30	₹ 5,370
F		**BRICK WORK**				
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1031,(page 2)	1ST CLASS BRICK-WORK IN 1:4 CEMENT & LOCAL-SAND MORTAR IN FOUNDATION & PLINTH				
			cum	9.91	6,400.95	₹ 63,436
G		**Plastering with mortar, 1:4**				
	CPWD Delhi SOR vol - 2, 2016, Code No 13.1(page 227)	Cement plastering including T&P, scaffolding, material and complete labpour, including cost of water, curing, racking of joints etc. with 12 mm cement plaster of mix :				
	CPWD Delhi SOR vol - 2, 2016, Code No 13.1.1(page 227)	1:4 (1 cement: 4 fine sand)	sqm	72.82	172.95	₹ 12,594
		Total				**₹ 117,470**

Abstract sheet of storm water drain						
Sl.n	**Item No**	**Description**	**Unit**	**Qty**	**Rate in Rs.**	**Amount in Rs.**
A		**Rate for Earthwork- Excavation**				
a	CPWD Delhi SOR vol - 1, 2016, Code No 2.6(page 76)	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge.				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.6.1(page 76)	In all type of soil				
		Total	cum	129.56	125.95	₹ 16,318
b		Refilling with excavated earth				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.25(page 79)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m	cum	47.16	125.75	₹ 5,930
B		**Plain Cement Concrete (P.C.C), 1:3:6**				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1(page 88)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1.5(page 88)	1:3:6 (1 Cement : 3 coarse sand (zone-III) : 6 graded stone aggregate 20 mm nominal size).				
		TOTAL B	cum	18.65	4,927.00	₹ 91,879
C		**Reinforced Cement Concrete (R.C.C), M30**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.34.1(page 102)	Providing and laying in position machine batched and machine mixed design mix M-30 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in	cum	7.94	6,515.95	₹ 51,724

		recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge.“(Note :- Cement content considered in M-30 is @ 340 kg/cum)				
D		**Reinforcement**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22(page 100)	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level.				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22.6(page 100)	Thermo-Mechanically Treated bars of grade Fe-500D or more.	MT	0.99	56,600.00	₹ 56,161
E		**Centering/ Shuttering**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.90(page 98)	Centring and shuttering with plywood or steel sheet upto two stories or height upto 7.5 metre above plinth level including strutting, propping etc. and removal of form for :				
a	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.1(page 98)	Foundations, footings, bases of columns, etc. for mass concrete	sqm	31.86	193.95	₹ 6,178
b	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.3(page 98)	Suspended floors, roofs, landings, balconies and access platform	sqm	73.44	422.30	₹ 31,014
F		**BRICK WORK**				
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1031,(page 2)	1ST CLASS BRICK-WORK IN 1:4 CEMENT & LOCAL-SAND MORTAR IN FOUNDATION & PLINTH				
			cum	30.55	6,400.95	₹ 195,547
G		**Plastering with mortar, 1:4**				
	CPWD Delhi SOR vol - 2, 2016, Code No 13.1(page 227)	Cement plastering including T&P, scaffolding, material and complete labpour, including cost of water, curing, racking of joints etc. with 12 mm cement plaster of mix :				

	CPWD Delhi SOR vol - 2, 2016, Code No 13.1.1(page 227)	1:4 (1 cement: 4 fine sand)	sqm	289.03	172.95	₹ 49,988
		Total				**₹ 504,741**

Abstract sheet of Operator room						
Sl.n	**Item No**	**Description**	**Unit**	**Quantity**	**Rate in Rs**	**Amount in Rs**
A		**Rate for Earthwork- Excavation**				
a	CPWD Delhi SOR vol - 1, 2016, Code No 2.6(page 76)	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge.				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.6.1(page 76)	In all type of soil	cum	52.123	125.95	**6565**
b		Refilling with excavated earth				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.25(page 79)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m	Cum	34.175	125.75	**4298**
B		**Plain Cement Concrete (P.C.C), 1:3:6**				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1(page 88)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1.5(page 88)	1:3:6 (1 Cement : 3 coarse sand (zone-III) : 6 graded stone aggregate 20 mm nominal size).				
		Total PCC	Cum	5.605	4,927.00	**27617**
C		**Reinforced Cement Concrete (R.C.C), M30**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.34.1(page 102)	Providing and laying in position machine batched and machine mixed design mix M-30 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site				

		of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge."(Note :- Cement content considered in M-30 is @ 340 kg/cum)				
			cum	5.51	6,515.95	**35929**
D		**Reinforcement**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22(page 100)	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level.				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22.6(page 100)	Thermo-Mechanically Treated bars of grade Fe-500D or more.				
		Total Reinforcement	MT	0.66	56,600.00	**37269**
E		**Centering/ Shuttering**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.90(page 98)	Centring and shuttering with plywood or steel sheet upto two stories or height upto 7.5 metre above plinth level including strutting, propping etc. and removal of form for :				
a	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.1(page 98)	Foundations, footings, bases of columns, etc. for mass concrete	sqm	30.4	193.95	**5891**
b	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.5(page 98)	Lintels, beams, plinth beams, girders, bressumers and cantilevers	Sqm	18.3	342.90	**6260**
c	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.3(page 98)	Suspended floors, roofs, landings, balconies and access platform	Sqm	27.7	422.30	**11710**
F		**BRICK WORK**				

	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1031,(page 2)	1ST CLASS BRICK-WORK IN 1:4 CEMENT & LOCAL-SAND MORTAR IN FOUNDATION & PLINTH	cum	8.9	6,400.95	**56739**
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1035,(page 2)	1ST CLASS BRICK-WORK IN 1:4 CEMENT & LOCAL-SAND MORTAR IN SUPER STRUCTURE	Cum	16.6	6,663.34	**110820**
H		**Plastering with mortar, 1:4**				
	CPWD Delhi SOR vol - 2, 2016, Code No 13.1(page 227)	Cement plastering including T&P, scaffolding, material and complete labpour, including cost of water, curing, racking of joints etc. with 12 mm cement plaster of mix :				
	CPWD Delhi SOR vol - 2, 2016, Code No 13.1.1(page 227)	1:4 (1 cement: 4 fine sand)	sqm	42.52	172.95	**7354**
I		**White wash**				
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1251,(page 10)	White washing with lime in one coat to give an even shade: 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	42.5	7.91	**336**
J		**Sanitary fittings**				
a	CPWD Delhi SOR vol - 2, 2016, Code No 17.11(page 295)	Providing and fixing white vitreous china laboratory sink with C.I. brackets, C.P. brass chain with rubber plug, 40 mm C.P brass waste and 40mm C.P. brass trap with necessary C.P. brass unions complete including painting of fittings and brackets, cutting and making good the wall wherever required :				

	CPWD Delhi SOR vol - 2, 2016, Code No 17.11.1(page 295)	Size 450x300x150 mm	Nos	2.0	2,392.60	**4785**
b	CPWD Delhi SOR vol - 2, 2016, Code No 17.1(page 292)	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 level white P.V.C. flushing cistern, including flush pipe, with manually controlled device (handle lever) conforming to IS : 7231, with all fittings and fixtures complete, including cutting and making good the walls and floors wherever required:				
	CPWD Delhi SOR vol - 2, 2016, Code No 17.1.1(page 292)	White Vitreous china Orissa pattern W.C. pan of size 580x440 mm with integral type foot rests	Nos	1.0	3,494.20	**3494**
K		**Door and Windows**				
	Trichy rate	Manufacture and installation of MS steel door with handle including all hinges and frames (Refer Drawing)	Nos.	2.0	2,900.00	**5800**
	Trichy rate	Manufacture and installation of MS steel window with handle including all hinges and frames (Refer Drawing)	Nos.	5.0	1,800.00	**9000**
		FLOORING				
L	CPWD Delhi SOR vol - 2, 2016, Code No 11.5(page 191)	62 mm thick cement concrete flooring with concrete hardener topping,under layer 50 mm thick cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20mm nominal size) and top layer 12mm thick cement hardener consisting of mix 1:2 (1 cement hardener mix : 2 graded stone aggregate, 6mm nominal size) by volume, hardening compound mixed @ 2 litre per 50 kg of cement or as per manufacture's specifications. This includes cost of cement	sqm	25.00	609.05	**15226**

		slurry, but excluding the cost of nosing of steps etc. complete.				
M		**Water Tank**				
	CPWD Delhi SOR vol - 2, 2016, Code No 18.48(page 334)	Providing and placing on terrace (at all floor levels) polyethylene water storage tank, IS : 12701 marked, with cover and suitable locking arrangement and making necessary holes for inlet, outlet and overflow pipes but without fittings and the base support for tank.	lts	2,000.00	7.25	**14500**
	CPWD Delhi SOR vol - 2, 2016, Code No 18.7.4(page 325)	Providing and fixing Chlorinated Polyvinyl Chloride (CPVC) pipes, having thermal stability for hot & cold water supply, including all CPVC plain & brass threaded fittings, including fixing the pipe with clamps at 1.00 m spacing. This includes jointing of pipes & fittings with one step CPVC solvent cement and testing of joints complete as per direction of Engineer in Charge. 32mm dia	m	10.00	289.05	**2891**
M		**Electrical**				
	55.4.1(RUIDP SOR 2017)	P & F double ball bearing capacitor start ceiling fan of approved make complete with regulator and other accessories as required. 900 mm sweep	each	1.00	₹ 1,481.00	**₹1,481.00**
	55.5(RUIDP SOR 2017)	P & F 1.6 mm thick M.S. Recessed fan box, hexagonal/ round of size 100 mm dia, depth 75mm, 12 mm dia rod fan hook with 100 mm length extended on each side .	each	1.00	₹ 114.00	**₹114.00**
	57.1.2(RUIDP SOR 2017)	P & F strip type fluorscent tube fitting fabricated from (CRCA sheet and finished with powder coating / stove enamelled paint)/(extruded non corrosive UV resist EP channel) complete with accessories like (OCCB, starter, starter seat)/ EB, rotor holder, terminal block duly prewired with copper conductor including making connection, testing etc. as required. (without tube): 1x 36 watts with OCCB	each	2.00	₹ 277.00	**₹554.00**
	57.7.1.2(RUIDP SOR 2017)	P & F Fluorscent tube rod in existing fixtures as required. 36/40 watts	each	2.00	₹ 36.00	**₹72.00**

	57.27.2(RUIDP SOR 2017/)	P & F of IP65 IK10 rated LED bulk head type ligh fixture made from CRCA sheet steel housing suitable for mounting LED tube system (integral driver), Powen consumption of 10-15W , 500-600 lumens system lumen efficiecy 70 lm/ watt output suitable for1x100 W GLS/ 9W CFL bulk head fixtures, life time of 50000 burning hours with 70% initial lumen maintained. CCT 3000° K, 4000° K and 6000° K. Fixture shall be in compliance with CE & KEMA standards. LED Bulk head luminaire 9/10W	each	1.00	₹ 1,271.00	**₹1,271.00**
	54.1(RUIDP SOR 2017)	Pipe Earthing as per IS:3043 with perforated 3.0 Mtr. Long, 40 mm dia. ' B ' class G.I. Pipe including all accessories like nut, bolts, reducer, nipple, wire meshed funnel, and C.C. finished chamber covered with hinged type with locking arrangement C.I. Cover, C.I. Frame of size 300mm x 300 mm and embodying the pipe complete with alternate layers salt and coke/ charcoal, testing of earth resistance as required.	each	1.00	₹ 3,000.00	**₹3,000.00**
	41.1.3(RUIDP SOR 2017)	Wiring of light point / fan point / exhaust fan point / call bell point with 1.5 sq. mm FR PVC insulated unsheathed 1.1kV grade flexible copper conductor and 1.5 sq.mm FR PVC insulated copper earth conductor (IS:694) of approved make in double lock/ ISI marked single lock pvc casing capping & it's accessories, 18 SWG M.S. box with earth terminal, screwless cage connectors for neutral looping in switch board & false ceiling point, 6 A switch 3.0 mm thick phenolic laminated sheet, zinc plated / brass screws, cup washers , making connections, testing etc. as required. long point upto 10 m	per point	4.00	₹ 487.00	**₹1,948.00**
	47.1(RUIDP SOR 2017)	P & F ISI marked (IS :3854) 6 amp. flush type switch including cutting hole in tile and making connection testing etc. as required.	nos	4.00	₹ 17.00	**₹68.00**
	47.18(RUIDP SOR 2017)	P & F ISI marked flush type 120/280 watt rotary step fan regulator including making connection testing etc. as required.	nos	4.00	₹ 221.00	**₹221.00**

	45.1(RUIDP SOR 2017)	P & F 18 SWG Sheet steel boxes duly finished with two coats of red oxide and with earthing terminal of following sizes (nominal size) on surface or in recessed as required. Size: 150 x 75 x 60 mm	nos	1.00	₹ 57.00	**₹57.00**
	46.1.1.1(RUIDP SOR 2017)	P&F 240/415 V MCB of breaking capacity not less than 10 KA (B/ C/ D tripping characteristic) ISI marked IS 8828(1996)]/ conforming to IEC 60898 in existing board/sheets including making connections with lugs, testing etc. as required. 0.5 to 4 A	nos	1.00	₹ 225.00	**₹225.00**
		Ladder				
	Rajasthan rate	Providing, fabricating and erecting MS ladder of 450mm wide made of 65 x 65 x 6mm angle iron and 20mm MS bars for walkway to top of the room including cutting, hoistng, fixing in position and applying a priming coat of approved steel primer complete in all respect as per specifications and the direction of the Engineer.	m	3.00	1,390.00	**₹225.00**
		Total				**₹ 375,721**

Abstract sheet of Store room						
Sl.n	**Item No**	**Description**	**Unit**	**Quantity**	**Rate in Rs**	**Amount in Rs**
A		**Rate for Earthwork- Excavation**				
a	CPWD Delhi SOR vol - 1, 2016, Code No 2.6(page 76)	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge.				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.6.1(page 76)	In all type of soil	cum	49.504	125.95	**6235**
b		Refilling with excavated earth				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.25(page 79)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m	Cum	32.921	125.75	**4140**
B		**Plain Cement Concrete (P.C.C), 1:3:6**				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1(page 88)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1.5(page 88)	1:3:6 (1 Cement : 3 coarse sand (zone-III) : 6 graded stone aggregate 20 mm nominal size).				
		Total PCC	Cum	6.478	4,927.00	**31918**
C		**Reinforced Cement Concrete (R.C.C), M30**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.34.1(page 102)	Providing and laying in position machine batched and machine mixed design mix M-30 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge.“(Note :- Cement content considered in M-30 is @ 340 kg/cum)				
			cum	7.83	6,515.95	**51035**
D		**Reinforcement**				

	CPWD Delhi SOR vol - 1, 2016, Code No 5.22(page 100)	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level.				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22.6(page 100)	Thermo-Mechanically Treated bars of grade Fe-500D or more.				
		Total Reinforcement	MT	0.76	56,600.00	**42814**
E		**Centering/ Shuttering**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.90(page 98)	Centring and shuttering with plywood or steel sheet upto two stories or height upto 7.5 metre above plinth level including strutting, propping etc. and removal of form for :				
a	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.1(page 98)	Foundations, footings, bases of columns, etc. for mass concrete	sqm	40.0	193.95	**7752**
b	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.5(page 98)	Lintels, beams, plinth beams, girders, bressumers and cantilevers	Sqm	25.8	342.90	**8835**
c	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.3(page 98)	Suspended floors, roofs, landings, balconies and access platform	Sqm	39.2	422.30	**16567**
F		**BRICK WORK**				
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1031,(page 2)	1ST CLASS BRICK-WORK IN 1:4 CEMENT & LOCAL-SAND MORTAR IN FOUNDATION & PLINTH	cum	13.7	6,400.95	**87718**
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1035,(page 2)	1ST CLASS BRICK-WORK IN 1:4 CEMENT & LOCAL-SAND MORTAR IN SUPER STRUCTURE	Cum	17.4	6,663.34	**116096**
H		**Plastering with mortar, 1:4**				
	CPWD Delhi SOR vol - 2, 2016, Code No 13.1(page 227)	Cement plastering including T&P, scaffolding, material and complete labpour, including cost of water, curing, racking of joints etc. with 12 mm cement plaster of mix :				
	CPWD Delhi SOR vol - 2, 2016, Code No 13.1.1(page 227)	1:4 (1 cement: 4 fine sand)	sqm	37.27	172.95	**6446**
I		**White wash**				

	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1251,(page 10)	White washing with lime in one coat to give an even shade: 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	37.3	7.91	**295**
K		**Door and Windows**				
	Trichy Rate	Manufacture and installation of MS steel door with handle including all hinges and frames (Refer Drawing)	Nos.	2.0	2,900.00	**5800**
	Trichy Rate	Manufacture and installation of MS steel window with handle including all hinges and frames (Refer Drawing)	Nos.	5.0	1,800.00	**9000**
		FLOORING				
K	CPWD Delhi SOR vol - 2, 2016, Code No 11.5(page 191)	62 mm thick cement concrete flooring with concrete hardener topping,under layer 50 mm thick cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20mm nominal size) and top layer 12mm thick cement hardener consisting of mix 1:2 (1 cement hardener mix : 2 graded stone aggregate, 6mm nominal size) by volume, hardening compound mixed @ 2 litre per 50 kg of cement or as per manufacture's specifications. This includes cost of cement slurry, but excluding the cost of nosing of steps etc. complete.	sqm	36.00	609.05	**21926**
		Electrical				
	Rajasthan Rate	P & F strip type fluorscent tube fitting fabricated from (CRCA sheet and finished with powder coating / stove enamelled paint)/(extruded non corrosive UV resist EP channel) complete with accessories like (OCCB, starter, starter seat)/ EB, rotor holder, terminal block duly prewired with copper conductor including making connection, testing etc. as required. (without tube): 1x 36 watts with OCCB	Nos	1.00	277.00	**277**
	Rajasthan Rate	P & F Fluorscent tube rod in existing fixtures as required. 36/40 watts	Nos	1.00	36.00	**36**
	Rajasthan Rate	Wiring of light point / fan point / exhaust fan point / call bell point with 1.5 sq. mm FR PVC insulated unsheathed 1.1kV grade flexible copper conductor and 1.5 sq.mm FR PVC insulated copper earth conductor (IS:694) of approved make in double lock/ ISI marked single lock pvc casing capping & it's accessories, 18 SWG M.S. box with earth terminal, screwless cage connectors for neutral looping in switch board & false ceiling point, 6 A switch 3.0 mm thick phenolic laminated sheet, zinc plated / brass screws, cup washers , making connections, testing etc. as required. long point upto 10 m	per point	2.00	487.00	**974**

	Rajasthan Rate	Providing & fixing following modular accessories made out of unbreakable and fire retardant poly carbonate with silver contacts including making connections testing etc. as required,6 A 3 pin shuttered socket, grade 1	per socket	1.00	111.00	**111**
		Total				**₹ 417,974**

		Abstract sheet of Generator room				
Sl.n	**Item No**	**Description**	**Unit**	**Quantity**	**Rate in Rs**	**Amount in Rs**
A		**Rate for Earthwork- Excavation**				
a	CPWD Delhi SOR vol - 1, 2016, Code No 2.6(page 76)	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge.				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.6.1(page 76)	In all type of soil	cum	4.368	125.95	**550**
b		Refilling with excavated earth				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.25(page 79)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m	Cum	3.410	125.75	**429**
B		**Plain Cement Concrete (P.C.C), 1:3:6**				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1(page 88)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1.5(page 88)	1:3:6 (1 Cement : 3 coarse sand (zone-III) : 6 graded stone aggregate 20 mm nominal size).				
		Total PCC	Cum	0.802	4,927.00	**3951**
C		**Reinforced Cement Concrete (R.C.C), M30**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.34.1(page 102)	Providing and laying in position machine batched and machine mixed design mix M-30 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge.“(Note :- Cement content considered in M-30 is @ 340 kg/cum)				
			cum	0.30	6,515.95	**1952**
D		**Reinforcement**				

	CPWD Delhi SOR vol - 1, 2016, Code No 5.22(page 100)	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level.				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22.6(page 100)	Thermo-Mechanically Treated bars of grade Fe-500D or more.				
		Total Reinforcement	MT	0.04	56,600.00	**2119**
E		**Centering/ Shuttering**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.90(page 98)	Centring and shuttering with plywood or steel sheet upto two stories or height upto 7.5 metre above plinth level including strutting, propping etc. and removal of form for :				
a	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.1(page 98)	Foundations, footings, bases of columns, etc. for mass concrete	sqm	4.0	193.95	**771**
b	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.3(page 98)	Suspended floors, roofs, landings, balconies and access platform	Sqm	2.9	422.30	**1236**
F		**BRICK WORK**				
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1031,(page 2)	1ST CLASS BRICK-WORK IN 1:4 CEMENT & LOCAL-SAND MORTAR IN FOUNDATION & PLINTH	cum	1.8	6,400.95	**11315**
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1035,(page 2)	1ST CLASS BRICK-WORK IN 1:4 CEMENT & LOCAL-SAND MORTAR IN SUPER STRUCTURE	Cum	1.9	6,663.34	**12815**
H		**Plastering with mortar, 1:4**				
	CPWD Delhi SOR vol - 2, 2016, Code No 13.1(page 227)	Cement plastering including T&P, scaffolding, material and complete labpour, including cost of water, curing, racking of joints etc. with 12 mm cement plaster of mix :				

	CPWD Delhi SOR vol - 2, 2016, Code No 13.1.1(page 227)	1:4 (1 cement: 4 fine sand)	sqm	8.65	172.95	**1497**
I		**White wash**				
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1251,(page 10)	White washing with lime in one coat to give an even shade: 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	8.7	7.91	**68**
K		**Door and Windows**				
	Trichy Rate	Manufacture and installation of MS steel door with handle including all hinges and frames (Refer Drawing)	Nos.	1.0	2,900.00	**2900**
	Trichy Rate	Manufacture and installation of MS steel window with handle including all hinges and frames (Refer Drawing)	Nos.	1.0	1,800.00	**1800**
		FLOORING				
K	CPWD Delhi SOR vol - 2, 2016, Code No 11.5(page 191)	62 mm thick cement concrete flooring with concrete hardener topping,under layer 50 mm thick cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20mm nominal size) and top layer 12mm thick cement hardener consisting of mix 1:2 (1 cement hardener mix : 2 graded stone aggregate, 6mm nominal size) by volume, hardening compound mixed @ 2 litre per 50 kg of cement or as per manufacture's specifications. This includes cost of cement slurry, but excluding the cost of nosing of steps etc. complete.	sqm	2.82	609.05	**1715**
		Total				**₹ 43,120**

		Abstract sheet of Sludge storage house				
Sl.n	Item No.	**Description**	**Unit**	**Quantity**	**Rate inRs**	**Amount in Rs**
A		**Rate for Earthwork- Excavation**				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.6(page 76)	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge.				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.6.1(page 76)	In all type of soil	cum	25.92	125.95	₹ 3,265
		Refilling with excavated earth				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.25(page 79)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m	cum	20.32	125.75	₹ 2,555
B		**Plain Cement Concrete (P.C.C), 1:3:6**				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1(page 88)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1.5(page 88)	1:3:6 (1 Cement : 3 coarse sand (zone-III) : 6 graded stone aggregate 20 mm nominal size).	Cum	10.4	4,927.00	₹ 51,275
C		**Reinforced Cement Concrete (R.C.C), M30**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.34.1(page 102)	Providing and laying in position machine batched and machine mixed design mix M-30 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering,	cum			

		finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge.“(Note :- Cement content considered in M-30 is @ 340 kg/cum)				
		Total RCC	Cum	5.59	6,515.95	₹ 36,437
D		**Reinforcement**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22(page 100)	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level.				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.22.6(page 100)	Thermo-Mechanically Treated bars of grade Fe-500D or more.	MT	0.8	56,600.00	₹ 47,051
E		**Centering/ Shuttering**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.90(page 98)	Centring and shuttering with plywood or steel sheet upto two stories or height upto 7.5 metre above plinth level including strutting, propping etc. and removal of form for :				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.1(page 98)	Foundations, footings, bases of columns, etc. for mass concrete	Sqm	59.7	193.95	₹ 11,579
F		**Solid Block masonry**				
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1035,(page 2)	1ST CLASS BRICK-WORK IN 1:4 CEMENT & LOCAL-SAND MORTAR IN SUPER STRUCTURE				

		Total	Cum	13.8	6,663.34	₹ 91,724
G		**Plastering with mortar, 1:4**				
	CPWD Delhi SOR vol - 2, 2016, Code No 13.1(page 227)	Cement plastering including T&P, scaffolding, material and complete labpour, including cost of water, curing, racking of joints etc. with 12 mm cement plaster of mix :				
	CPWD Delhi SOR vol - 2, 2016, Code No 13.1.1(page 227)	1:4 (1 cement : 4 fine/ coarse sand)	sqm	125.1	172.95	₹ 21,636
H		**Roof**				
a	CPWD Delhi SOR vol - 1, 2016, Code No 10.20(page 182)	Structural steel work riveted, bolted or welded in built up sections, trusses and framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer all complete.	kg	2,664.1	67.60	₹ 180,090
b	CPWD Delhi SOR vol - 1, 2016, Code No 12.1(page 692)	Providing corrugated G.S. sheet roofing including vertical / curved surface fixed with polymer coated J or L hooks, bolts and nuts 8 mm diameter with bitumen and G.I. limpet washers or with G.I. limpet washers filled with white lead, including a coat of approved steel primer and two coats of approved paint on overlapping of sheets complete (up to any pitch in horizontal/ vertical or curved surfaces), excluding the cost of purlins, rafters and trusses and including cutting to size and shape wherever required.	sqm	115.56	957.95	₹ 110,704
		Total				**₹ 556,316**

Asbtract sheet of Flexible Pavement						
Sl.no		**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
A		**Subgrade**				
	CPWD Delhi SOR vol - 2, 2016, Code No 16.10(page 265)	Preparation and consolidation of sub grade with power road roller of 8 to 12 tonne capacity after excavating earth to an average of 22.5 cm depth, dressing to camber and consolidating with road roller including making good the undulations etc. and re-rolling the sub grade and disposal of surplus earth with lead upto 50 metres.				
			sqm	1,565.00	90.10	₹ 141,007
B		**Granular Sub base**				
	CPWD Delhi SOR vol - 2, 2016, Code No 16.78(page 278)	Construction of granular sub-base by providing close graded Material conforming to specifications, mixing in a mechanical mix plant at OMC, carriage of mixed material by tippers to work site, for all leads & lifts, spreading in uniform layers of specified thickness with motor grader on prepared surface and compacting with vibratory power roller to achieve the desired density, complete as per specifications and directions of Engineer-in-Charge				
	CPWD Delhi SOR vol - 2, 2016, Code No 16.78.3(page 279)	With material conforming to Grade-III (size range 26.5 mm to 0.075 mm) having CBR Value-20	cum	524.28	1931.45	₹ 1,012,611
C		**Wet Mix Macadam**				
	CPWD Delhi SOR vol - 2, 2016, Code No 16.79(page 279)	Providing, laying, spreading and compacting graded stone aggregate (size range 53 mm to 0.075 mm) to wet mix macadam (WMM) specification including premixing the material with water at OMC in for all leads & lifts, laying in uniform layers with mechanical paverfinisher in sub- base / base course on well prepared surface and compacting with vibratory roller of 8 to 10 tonne capacity to achievethe	cum	352.13	2,132.250	₹ 750,819

		desired density, complete as per specifications and directions of Engineer-in-Charge.				
D		**Bituminous Macadam**				
	CPWD Delhi SOR vol - 2, 2016, Code No 16.55(page 274)	Providing and laying bituminous macadam using crushed stone aggregates of specified grading premixed with bituminous binder, transported to site by tippers, laid over a previously prepared surface with paver finisher equiped with electronic sensor to the required grade, level and alignment and rolling with smooth wheeled, vibratory and tandem rollers as per specifications to achieve the desired compaction and density, complete as per specificatons and directions of Engineer-in-Charge.				
	CPWD Delhi SOR vol - 2, 2016, Code No 16.55.2(page 274)	50 to 100 mm average compacted thickness with bitumen of grade VG-30 @ 3.50% (percentage by weight of total mix) prepared in Drum Type Hot Mix Plant of 60-90 TPH capacity.	cum	78.250	5606.1	₹ 438,677
E		**Bituminous Concrete**				
	CPWD Delhi SOR vol - 2, 2016, Code No 16.57(page 274)	Providing and laying Bituminous concrete using crushed stone aggregates of specified grading, premixed with bituminous binder and filler, transporting the hot mix to work site by tippers, laying with paver finisher equiped with electronic sensor to the required grade, level and alignment and rolling with smooth wheeled, vibratory and tandem rollers to achieve the desired compaction and density as per specification, complete and as per directions of Engineer-in-Charge				
	CPWD Delhi SOR vol - 2, 2016, Code No 16.57(page 274)	40/50 mm compacted thickness with bitumen of grade VG-30 @ 5.5% (percentage by weight of total mix) and lime filler @ 3% (percentage by weight of Aggregate) prepared in Batch Type Hot Mix Plant of 100-120 TPH capacity.	cum	31.300	7863.85	₹ 246,139
		Total				**₹ 2,589,252**

Asbtract sheet of Flexible Pavement						
Sl.n		**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
A		**Subgrade**				
	CPWD Delhi SOR vol - 2, 2016, Code No 16.10(page 265)	Preparation and consolidation of sub grade with power road roller of 8 to 12 tonne capacity after excavating earth to an average of 22.5 cm depth, dressing to camber and consolidating with road roller including making good the undulations etc. and re-rolling the sub grade and disposal of surplus earth with lead upto 50 metres.				
			sqm	412.25	90.10	₹ 37,144
B		**Granular Sub base**				
	CPWD Delhi SOR vol - 2, 2016, Code No 16.78(page 278)	Construction of granular sub-base by providing close graded Material conforming to specifications, mixing in a mechanical mix plant at OMC, carriage of mixed material by tippers to work site, for all leads & lifts, spreading in uniform layers of specified thickness with motor grader on prepared surface and compacting with vibratory power roller to achieve the desired density, complete as per specifications and directions of Engineer-in-Charge				
	CPWD Delhi SOR vol - 2, 2016, Code No 16.78.3(page 279)	With material conforming to Grade-III (size range 26.5 mm to 0.075 mm) having CBR Value-20	cum	103.06	1931.45	₹ 199,060
C		**Wet Mix Macadam**				
	CPWD Delhi SOR vol - 2, 2016, Code No 16.79(page 279)	Providing, laying, spreading and compacting graded stone aggregate (size range 53 mm to 0.075 mm) to wet mix macadam (WMM) specification including premixing the material with water at OMC in for all leads & lifts, laying in uniform layers with mechanical paverfinisher in sub- base / base course on well prepared surface and compacting with vibratory roller of 8 to 10 tonne capacity to achievethe desired density, complete as per specifications and directions of Engineer-in-Charge.	cum	92.76	2,132.250	₹ 197,780

D		**Cement Concrete 1:2:4**				
	CPWD Delhi SOR vol - 2, 2016, Code No 16.42(page 271)	Cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 40 mm nominal size) in pavements, laid to required slope and camber in panels as required including consolidation finishing and tamping complete.	cum	82.450	5503.8	₹ 453,788
		Total				**₹ 887,772**

Measurement sheet of Boundary wall						
Sl.n	**Item No.**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
A		**Rate for Earthwork- Excavation**				
1	CPWD Delhi SOR vol - 1, 2016, Code No 2.6(page 76)	Earth work in excavation in open area, STP, WTP, Pumping station with mechanical means including dressing of sides and ramming of bottoms, including getting out the excavated material, disposal of excavated material lead upto 1000m at suitable site as per as per drawing and as per direction of Engineer. (Measurements for payment to be done as per standard drawings).				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.6.1(page 76)	In all type of soil	**cum**	325.91	125.95	₹ 41,048.83
b		Refilling with excavated earth				
	CPWD Delhi SOR vol - 1, 2016, Code No 2.25(page 79)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m				
			cum	96.14	125.75	₹ 12,090.16
B		**Plain Cement Concrete (P.C.C), 1:3:6**				
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1(page 88)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :				
	CPWD Delhi SOR vol - 1, 2016, Code	1:3:6 (1 Cement : 3 coarse sand (zone-III) : 6 graded stone aggregate 20 mm nominal size).				

	No 4.1.5(page 88)					
		Total	**Cum**	46.56	4927.00	₹ 229,396.69
C		**Centering/Shuttering**				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.90(page 98)	Centring and shuttering with plywood or steel sheet upto two stories or height upto 7.5 metre above plinth level including strutting, propping etc. and removal of form for :				
	CPWD Delhi SOR vol - 1, 2016, Code No 5.9.1(page 98)	Foundations, footings, bases of columns, etc. for mass concrete	**sqm**	125.83	193.95	₹ 24,403.84
D		**Damp proof coarse**				
	CPWD Delhi SOR vol - 2, 2016, Code No 4.10(page 90)	**Providing and laying damp-proof course 40mm thick with cement concrete 1:2:4 (1 cement : 2 coarse sand (zone-III): 4 graded stone aggregate 12.5mm nominal size)**	**sqm**	101.55	263.10	₹ 26,718.91
E		**Brick Work**				
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1031,(page 2)	1ST CLASS BRICK-WORK IN 1:4 CEMENT & LOCAL-SAND MORTAR IN FOUNDATION & PLINTH	**cum**	183.21	6400.95	₹ 1,172,719.20
	SR(2015-16) for building works by GM,GPCU, jal nigam, Lucknow. Item Code 1035,(page 2)	1ST CLASS BRICK-WORK IN 1:4 CEMENT & LOCAL-SAND MORTAR IN SUPER STRUCTURE	**cum**	203.11	6663.34	₹ 1,353,380.33
		Total				**₹ 2,859,758**

Abstract sheet of Additional Works						
Sl.n	**Item No.**	**Description**	**Unit**	**Quantity**	**Rate in Rs.**	**Amount in Rs.**
1		**Water Supply Works**				
A		**Water Storage Tank**				
	CPWD Delhi SOR vol - 2, 2016, Code No 18.48(page 334)	Providing and fixing of Sintex Tank (3 layers) 2000 liters capacity next to the bore well under the ground as a sump tank. includes cost and conveyance of all materials like valve and brackets etc. complete as directed by the Engineer In charge	Litre	2,000.00	7.25	₹ 14,500
B	CPWD Delhi SOR vol - 2, 2016, Code No 18.9(page 325)	Providing and fixing Chlorinated Polyvinyl Chloride (CPVC) pipes, having thermal stability for hot & cold water supply including all CPVC plain & brass threaded fittings This includes jointing of pipes & fittings with one step CPVC solvent cement, trenching, refilling & testing of joints complete as per direction of Engineer in Charge.				
	CPWD Delhi SOR vol - 2, 2016, Code No 18.9.4(page 326)	32mm dia CPVC pipes	RMT	188.00	250.55	₹ 47,103
	CPWD Delhi SOR vol - 2, 2016, Code No 18.15.1(page 327)	Providing and fixing of 15mm dia brass bib Cock water tap	Nos	5.00	260.10	₹ 1,301
2		**Civil Works for the fixing of Prefabricated Water tank**				
A		Rate for Earthwork- Excavation				
a	CPWD Delhi SOR vol - 1, 2016, Code No 2.6(page 76)	Earth work in excavation by mechanical means (Hydraulic excavator)/manual means over areas (exceeding 30 cm in depth, 1.5 m in width as well as 10 sqm on plan) including getting out and disposal of excavated earth lead upto 50 m and lift upto 1.5 m, as directed by Engineer-in-charge.				

		Excavation	Cum	10.00	125.95	₹	1,260
B		**PCC bed**					
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1(page 88)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :					
	CPWD Delhi SOR vol - 1, 2016, Code No 4.1.5(page 88)	1:3:6 (1 Cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size).	cum	0.40	4,927.00	₹	1,971
3		**Landscaping**					
a	39.24(RUIDP SOR 2017 page 264)	Planting Flowering Plants and Shrubs in Central Verge.	km	0.26	69,400.00	₹	18,252
b	39.18(RUIDP SOR 2017 page 264)	Making lawns including ploughing and breaking of clod, removal of rubbish, dressing and supplying doobs grass roots and planting at 15 cm apart, including supplying and spreading of farm yard manure at rate of 0.18 cum per 100 sqm.	Sqm	1,512.00	39.00	₹	58,968
4		**Electrical Works**					
		Supply of 7.5KVA Silent DG.set with comprising of Mahindra make Engine Model 1125GR, 12BHP @ NTP 1500RPM coupled to 7.5KVA Mahindra approved make 3-Phase, 415V, 50Hz alternator mounted on a common Base frame along with other accessories i.e., Fuel tank, Manual Control Panel, Battery with leads and acoustic enclosure.	1	1.00	190,000.00	₹	190,000
5		**Borewell Works**					
	Market price	Conduct Hydrogeological investication to determine the most probably spot for bore hole to obtain water. The scientific investication is to be carried in the pressence and in the	Nos	1.00	10,000.00	₹	10,000

		directions of the engineer and using specialised resistivity measuring instruments.					
	RUIDP SOR 2017 20.1.3	Construction of Tube-well upto 100 Meter depth and above in all type of rocks by DTH system and over burden to accommodate casing pipe of following sizes in all types of soils and over burden including lowering of casing pipes,excluding the cost of casing pipes as per IS : 2800 (Part I & II) 1979 specifications. The work would be completed after obtaining sand free water and as per direction of the engineer. The tube well should have a throughout bore as per nominal dia of casing pipe:150 mm dia nominal bore	m	35.00	580.00	₹	20,300
	RUIDP SOR 2017 20.4.3	Supply of ERW M.S black casing pipe ISI marked (IS: 4270/1992) of grade Fe410 of following nominal bore sizes at site of work - 150 mm diameter	m	26.00	1,287.00	₹	33,462
	RUIDP SOR 2017 20.5.1	Supply of strainer pipes made of ERW M.S. black pipe ISI mark of following sizes at the site of work including required size of slotting as per IS: 8110 -1985 of following nominal bore sizes at site of work. Nominal bore dia: 150 mm	m	5.00	1,300.00	₹	6,500
	RUIDP SOR 2017 20.6	Testing verticality of tube well by plumbing system and yeild test and draw down test by pumping system as per IS: 2800 (part II) 1979	Nos	1.00	7,260.00	₹	7,260
	RUIDP SOR 2017 20.7.3	Supply and fixing of tube well cover of M.S sheet(6 mm thick) with nuts and bolts complete for casing size of 150 mm dia	nos	1.00	236.00	₹	236
	RUIDP SOR 2017 20.8	Supply and fixing of MS clamp set of 50 x 6 mm flat iron with nuts and bolts etc for holding the riser pipe assembly of submersible pump set	each set	1.00	260.00	₹	260

	RUIDP SOR 2017 20.9	Installation of submersible motor pump set in tube well complete (labour charges only) including transportation of tripod, pulley block, and any other material required for lowering purpose	each	1.00	3,509.00	₹	3,509
	RUIDP SOR 2017 20.10.1	Providing and lowering of GI flange pipe B class including rubber washer and nuts of 8 mm dis complete in all respect - 50 mm	metre	32.00	539.00	₹	17,248
6		**Gate at the entrance on compund wall**					
		Providing and fixing M.S. Gate as per chief architect drawing, using 50x50mm 14 guage MS hollow pipe frame work bent to ornamental shape as shown in drawing and 35mmx6mm and 16mmx16mm square rods for verticlas alternatively spaced at 4cm c/c in two halves and 40mmx6mm MS flats for horizontal members and at the top cast iron spikes are provided at alternate vartical members as shown in the drawing etc. complete. All the steel surface should be thoroughly cleaned free of rust and painted with anti corrosive paint(Shop paint) etc. complete. the work includes the cost of all materials, labor charges for all items of work, hire charges for welding, cutting and grinding equipment, and electricity charges, with lead and lift, loading and loading charges etc.complete as per specification	sqm	20.00	3,089.00	₹	61,780
7		**Tiller for drying beds**					
		Supply of tiller for removal of sludge from drying deds with design approved by Engineer incharge	LS	1.00	227,175.00	₹	227,175
8		Providing & fixing Steel Structure to support overhead tank at operator room at 2m height with Angle iron 45X45X5mm, MS flats 20mm X 6mm, aluminium paint primer, including labour charges, HOM machineries	kg	173.00	60.00	₹	10,380
9	CPWD Delhi SOR vol - 1,	Coursed rubble masonry with hard stone and cement mortar 1:6 for steps at slope	cum	0.20	4,639.90	₹	928

	2016, Code No 7.6.1(page 119)					
10		Providing and Laying Reinforced cement concrete pipe NP4/ prestressed concrete pipe for culverts including jointing ends and fixing collar with cement mortar 1:2 complete as per clause 1000 & 2900 of MoRT&H specification including all material, labour form work, machinery. Pipes to be laid at an interval of every 25 metres below road				
	RUIDP SOR 2017 11.2.2	200 mm internal diameter	Rmt	10.00	551.00	₹ 5,510
		Total				**₹ 737,902**

		Asbtract of refilling sheet				
Sl.n	**Item No.**	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
A		**Refilling with excavated earth**				
1	CPWD Delhi SOR vol - 1, 2016, Code No 2.25(page 79)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m				
			cum	1,917.26	125.75	₹ 241,095
		Refiliing of excavated earth below EGL is considered in indiviual modules and units. Above mentioned refilling refers to the extra refilling required to achieve the FGL at 100.00 around all the modules and units				
		Total				**₹ 241,095**

Electrical Works							
Sl.n		**Description**	**Unit**	**Nos**	**Quantity**	**Unit rate**	**Amount**
1		**Street Lighting**					
	RUIDP SOR 2017 58.16.1	Supply and erection of hot dipped galvanised steel swaged tubular pole /GI Conical Pole conforming to IS 2713-1980 (part I to II) with galvanised base plate of size 400mm x 400mm x 7mm in position including excavation of the pit and filling the same with C.C. of M- 10/M-20 grade (1:3:6)/ grade(1:1.5:3) from base plate to 50cm above ground level, with the help of steel frame not less than 40 cm dia up to 114.3mm outer dia and 50 cm beyond 114.3mm outer dia around the pole. Duly finished with cement plaster, earthing terminals , cable entry, GI cable sleeve complete as required. The pole shall be galvanised using ISI mark tube for structural purpose.					
		7/7.5 Mtr. Group 1	Nos	7	7.00	17,781.00	₹124,467.00
	RUIDP SOR 2017 58.1.1	P & F IP-43 protected street light luminaire on existing bracket suitable for FTL, made out from CRCA sheet steel finished with stove enameled paint, having deep drawn aluminium alloy canopy reflector cum control gear tray, clear ribbed acrylic diffuser held with synthetic gasket, with all necessary accessories copper wound ballast, capacitor, starter, holder prewired with pvc insulated copper conductor including making connection testing etc. as required. (without tube). Grade 1	Nos	7	7.00	1,171.00	₹8,197.00
	RUIDP SOR 2017 57.7.1.2	P & F Fluorscent tube rod in existing fixtures as required. 36/40 watts	Nos	7	7.00	36.00	₹252.00
	RUIDP SOR 2017 41.3.4	Wiring of 3 pin 6 amp. Light plug point with 1.5 sq. mm FR PVC insulated unsheathed 1.1 kV grade flexible copper conductor and 1.5 sq.mm FR PVC insulated unsheathed 1.1 kV grade copper earth conductor (IS:694) of approved make double lock/ ISI marked single lock pvc casing capping & it's accessories, 18 SWG M.S. box with earth terminal, screwless cage connectors for neutral looping in switch board & falce ceiling point, 6 A switch, 6 A socket, 3.0 mm thick phenolic laminated sheet, zinc	Nos	7	7.00	537.00	₹3,759.00

		plated / brass screws, cup washers, making connections, testing etc. as required.Long point. Also includes cost of trenching as and when required and refilling					
	Non standard	Supply and installation of 16 A swtich for controlling power supply to street lights, including providing neccesary panel boxes, connection, accessories . Complete	Nos	2	2.00	200.00	₹400.00
2		**Supply to Pumps**					
	a	Supply and providing 3 phase, 16 amp power supply point housed inside IP65 panel, including cost of panel, erection, cost of manking connections, cables, joints etc. Complete as directed by engineer. Panel dimensions : 300 mm x 300 mm x 150 mm placed at a distance of 500 mm above ground level and made from fire resistant FRV/MS coated with zinc oxide	Nos	7	7.00	2000	₹14,000.00
	b	Providing & Laying XLPE insulated / P.V.C. sheathed cable of 1.1 KV grade with aluminium conductor Armoured of IS:7098-I/1554-1 approved make in ground as per IS:1255 including excavation of 30cmx75cm size trench, 25 cm thick under layer of sand, second Class bricks covering, refilling earth, compaction of earth, making necessary connection, testing etc. as required of size.			-		
	c	6 Sq.mm, 3 core	rmt	1	1.00	151	₹151.00
	d	P&F 240/415 V MCB of breaking capacity not less than 10 KA (B/ C/ D tripping characteristic) ISI marked IS 8828(1996)]/ conforming to IEC 60898 in existing board/sheets including making connections with lugs, testing etc. as required.Single pole MCB 6 A to 32 A	Nos	7	7.00	161	₹1,127.00
3		**Pumps**					
	a	Supply and installation of mono block pump to pump water from underground sump to overhead tank . Pump power: 1 HP	Nos	1	1.00	8500	₹8,500.00
	b	Dewatering pump for reusing final treated water for gardening purpose, to be mounted on a mobile platform. Power power: 2 Hp	Nos	1	1.00	12000	₹12,000.00
	c	Supply and installation of submersible pump for borewell, with head of 30 m and as specified in bid document	Nos	1	1.00	45000	₹45,000.00
4		**Generator**					

		Supply of 7.5KVA Silent DG.set with comprising of Mahindra make Engine Model 1125GR, 12BHP @ NTP 1500RPM coupled to 7.5KVA Mahindra approved make 3-Phase, 415V, 50Hz alternator mounted on a common Base frame along with other accessories i.e., Fuel tank, Manual Control Panel, Battery with leads and acoustic enclosure.	Nos	1	1.00	190000	₹190,000.00
		Total					**₹407,853.00**

Costing of tools					
Sl.no.	**Description**	**Unit**	**Quantity**	**Rate**	**Amount**
A	Gum boots	Nos	4	1,000.00	4,000.00
B	Plastic drums	Nos	2	500.00	1,000.00
C	Rakes	Nos	3	200.00	600.00
D	Tarpaulin sheet: 9x9 ft size	Nos	6	300.00	1,800.00
E	Broom	Nos	4	50.00	200.00
F	pH meter	Nos	1	700.00	700.00
G	Mask	Nos	5	100.00	500.00
H	Spanner	Nos	1	200.00	200.00
I	Gloves	Nos	4	200.00	800.00
J	First Aid box	Nos	1	400.00	400.00
K	Hose pipe	m	80	35.00	2,800.00
L	Shovel	Nos	2	2,000.00	4,000.00
M	Wheel barrow	Nos	2	5,000.00	10,000.00
O	Plant trimmer	Nos	1	200.00	200.00
P	Sludge measuring device	Nos	1	4,000.00	4,000.00
				Total	**31,200.00**

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