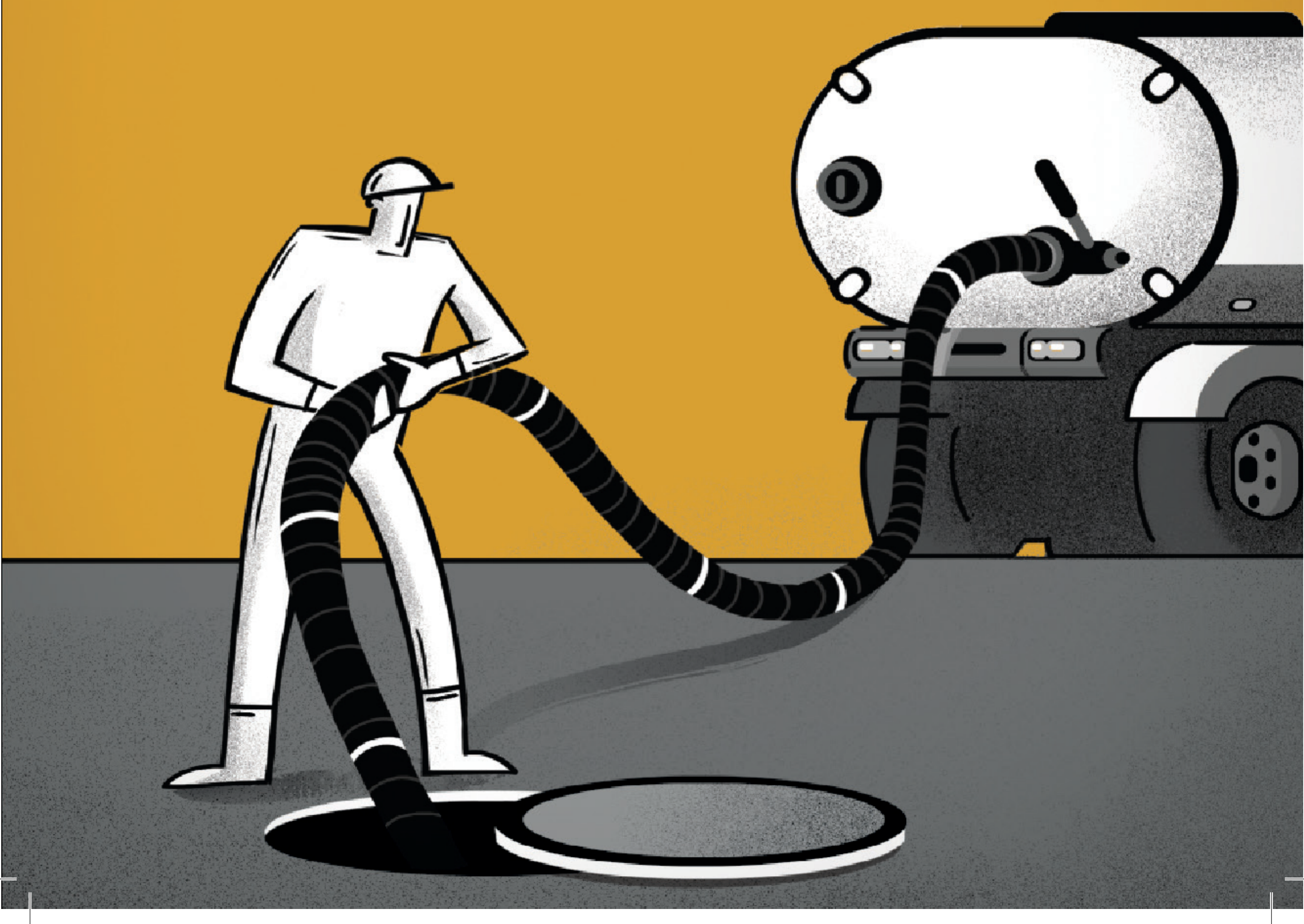
MAINSTREAMING CO-TREATMENT OF FAECAL SLUDGE & SEPTAGE (FSS) IN STPS IN UTTAR PRADESH

CO-TREATMENT OF FSS OPTIONS AT BHARWARA STP LUCKNOW



MAINSTREAMING CO-TREATMENT OF FAECAL SLUDGE & SEPTAGE (FSS) IN STPS IN UTTAR PRADESH:

CO-TREATMENT OF FSS OPTIONS AT BHARWARA STP LUCKNOW

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Abbreviations

ASP	Activated Sludge Process
BOD	Biochemical Oxygen Demand
CAPEX	Capital Expenditure
COD	Chemical Oxygen Demand
CSE	Centre for Science and Environment
CSP	City Sanitation Plan
CT	Community Toilet
DoUD	Department of Urban Development
DTS	Dry Ton Solids
DWWT	Decentralized Wastewater Treatment Plant
FOG	Fats Oil and Grease
FSS	Faecal Sludge and Septage
FSSM	Faecal Sludge and Septage Management
GoI	Government of India
GoUP	Government of Uttar Pradesh
HLR	Hydraulic Loading Rate
IS	Indian Standard
Km	Kilometres
KwH	Kilowatt Hour
LNN	Lucknow Nagar Nigam
LMC	Lucknow Municipal Corporation
MD	Mechanical De-watering
MLD	Million Litres per Day
MoHUA	Ministry of Housing and Urban Affairs
MPS	Main Pumping Station
NGO	Non-Governmental Organization
NGT	National Green Tribunal
O&M	Operation & Maintenance
ODF	Open Defecation Free
OLR	Organic Loading Rate
OPEX	Operational Expenditure
PPE	Personnel Protective Equipment
PT	Public Toilet
SBM	Swachh Bharat Mission
SBR	Sequential Batch Reactor
SFD	Shit (or Excreta) Flow Diagram
SPS	Sewage Pumping Station
SS	Suspended Solids
STP	Sewage Treatment Plant
SVI	Sludge Volume Index
TS	Total Solids
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
UASB	Upflow Anaerobic Sludge Blanket
ULB	Urban Local Body
UPJN	Uttar Pradesh Jal Nigam

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Executive summary

As per Census 2011, 51% of urban households in India are dependent on Onsite Sanitation Systems (OSS). Under the Swachh Bharat Mission, around 30 million more septic tanks/pits (OSS) will be constructed by the end of 2019, producing another 180 million litres of faecal sludge and septage (FSS) everyday. Due to lack of faecal sludge treatment facilities, the cesspool vehicles that empty the septic tanks/pits, discharge FSS either in open fields, drains or in water bodies. This results in the contamination of water sources like rivers, lakes and the ground water that ultimately leads to public health hazards. The treatment of FSS is, therefore, of paramount importance.

Co-treatment is a process where an Sewage Treatment Plant (STP), in addition to treating the domestic sewage transported through a sewerage city, also treats FSS emptied from various Onsite Sanitation Systems prevalent in the city.

For cities that are partially covered with sewerage network, co-treatment of FSS in existing STPs provides a cheaper alternative to treating FSS generated from areas without a sewarage network. 100% coverage of sewerage network in a city is costly and difficult to be implemented especially in densely populated areas. Setting up of a dedicated faecal sludge treatment plant (FSTP) is a time-consuming affair due to issues such as land identification, clearances and tendering process. Further, in case of co-treatment, the existing facilities, site infrastructure and manpower of the STP can also be used for co-treatment and thus can eliminate the problem of engaging a new O&M operator and additional cost related to site infrastructure.

Existing co-treatment practice: In many cities in India, FSS is directly added without any pre-treatment, either at the inlet of the STP or at the nearest pumping station or manhole of the sewerage network. There are learnings from various countries on the detrimental impact of co-treatment of FSS in an STP without any pre-treatment.

The considerably higher solids, organic and nutrient load of FSS as compared to sewage, can lead to severe operational problems such as solids deposition, clogging and corrosion of sewerage infrastructure, including STP. This is because the diameter and slope of sewers are designed for the transport of municipal wastewater typically containing 250 to 600 mg TSS/L rather than the 12,000 to 52,500 mg TSS/L present in FSS. Further, the high strength of FSS can have a large impact on the organic, suspended solids and nitrogen loads on the STP and thus impact its treatment efficiency. The intermittent nature of FSS loading will give rise to high instantaneous loads and thus amplify the problems.

To assess the feasibility of co-treatment in an STP, the following points need to be studied:

1. The spare capacity in the STP to treat the additional load from FSS.
2. Study the treatment process of the STP and identify the limiting factors, which can affect treatment efficiency like F/M ratio, oxygen requirement in case of aerobic process and pH, ammoniacal nitrogen content in anaerobic process.

3. Existing treatment efficiency of the STP.
4. Land availability for construction for co-treatment modules for pre-treatment of FSS.
5. Distance of STP from the city to assess the economic feasibility of co-treatment of FSS.

The report presents an analysis for potential of co-treatment as a step ahead for the city of Lucknow in achieving citywide sanitation. In order to map interventions required across sanitation value chain (i.e. containment, emptying, transport and treatment), a shit flow diagram was prepared for Lucknow which shows 47% of population is dependent on OSS and the excreta generated from 39% of the population is unsafely managed. Co-treatment is an ideal solution for treatment of FSS generated from the OSS in the city since there is partial sewerage coverage and two operational STPs in the city.

The STP at Bharwara (Lucknow) was studied for feasibility of co-treatment. The STP has a capacity to treat 345 MLD of sewage. The STP uses UASB reactor followed by aeration tanks and polishing ponds. The average influent characteristics at the STP includes BOD, COD and TSS of 140 mg/l, 275 mg/l and 230 mg/l, respectively. The treated effluent meets the previously notified discharge standards of BOD 30 mg/l and TSS 50 mg/l to water bodies. However, the STP does not meet the standards set by a National Green Tribunal (NGT) order dated 30.04.2019.

During CSE's site visit, it was observed that the UASB reactor might not be working efficiently. Foam formation was observed after the UASB reactor. Low sludge retention time (1–2 days) in the UASB reactor was identified as one possible reason. **It is recommended to study the STP treatment efficiency by collecting wastewater samples from influent and effluent of each module of the STP to evaluate how each module is working. Samples from the UASB reactor are also recommended to be taken to measure key parameters like pH, ammoniacal nitrogen content and F/M ratio in order to ascertain whether optimal conditions are being maintained in the reactor for effective biological treatment.** Interventions like ensuring sludge retention time in the UASB reactor to at least 2–4 weeks, installation Fats-Oil-Grease treatment unit at the inlet of the STP can also be taken.

Even though the STP is working at full capacity, co-treatment can still be done since existing load of FSS reaching the main pumping station is only 0.006% of the STP capacity and the influent sewage received at the STP has an organic load lower than typical sewage. **In order to avoid system failure in the future, it is recommended to study the local FSS characteristic and explore various options for co-treatment where FSS is pre-treated before being discharged into an STP**.

The characteristics of the FSS are highly variable and dependent upon many local factors like type of containment, storage duration, type of establishment, emptying method, climate etc. The CSE lab conducted testing of FSS in Bijnor and Chunar, located at extreme ends of the state of Uttar Pradesh. Testing conducted by UPJN of the FSS received at MPS was also observed. Huge variation in the BOD and COD level were observed in the samples. **It was found that COD varies from 6,000 mg/L to 120,000 mg/L. It was considered prudent to consider a scenario analysis of low-strength, medium-strength and high-strength influent FSS and study the impact on treatment efficiency of the STP.**

Taking into account the variability of FSS characteristics, the spare capacity of STP to treat organic load was evaluated. It was found that the STP can treat between 0.5 MLD to 11.5 MLD (i.e. 0.2% to 3.3% of the capacity of the STP) of influent FSS. Considering the absence of a study to evaluate the impact of FSS addition on other limiting factors like pH, nutrient load, F/M ratio, a worst case scenario is considered and **it is recommended to restrict the overall FSS discharging to the STP to 0.5 MLD (or 0.2% of STP capacity) to start with. Depending upon the performance of the STP, the volume of FSS influent can be increased gradually**. The recommended restriction on FSS addition is sufficient to treat the present demand of 30 KLD from de-sludging operators operating in the locality. Further, the addition of a solid–liquid separation module would mean that effectively only 15 KLD (approximately) of additional influent would reach the STP whose COD would be much lower than that of influent FSS discharged by the de-sludgers

Five options of modules (30 KLD capacity) for co-treatment of FSS in Bharwara, STP is presented in the report. Out of which Option-1: non-mechanized solid-liquid separation using Settling Thickening Tank and Option-2: mechanized solid–liquid separation using screw press, is suggested.

Option-1 is suitable for TS>1% and partially digested FSS (i.e. COD to BOD_5 ratio greater than 2). This would need approximately 90 to 100 sqm area and Rs 23 lakhs capital cost. The option would need active sludge management and a dedicated drying beds to treat the separated solids (not included in the cost).

Option-2 is suitable for TS>1% and for larger plants with availability of spare parts, skilled manpower, regular power supply, good supply chain of polymer for dosing. Approximate area required for this option is 100–120 sqm and a capital cost of Rs 33.5 lakhs. The separated solids from this option would have a TS in the range of 15–25% and thus significantly reducing on land requirement for sludge drying beds.

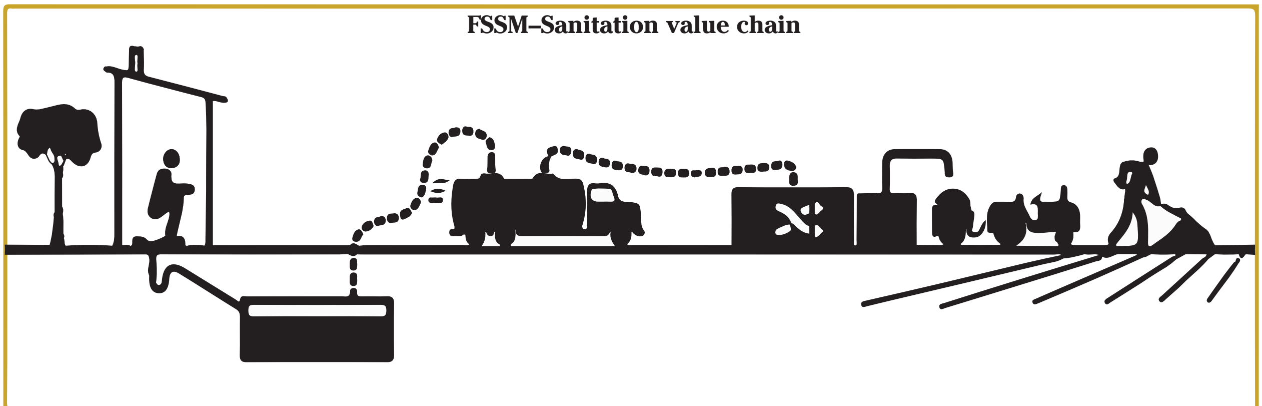
Sludge / Bio-solids generated from the co-treatment is rich in nutrient content (as compared to STP sludge) and has good potential for use in agriculture. In order to reduce the pathogen content and further improve the quality of bio-solids, co-composting of sludge generated from FSS treatment with organic municipal solid waste can be done.

1. Background

1.1 Need for Faecal Sludge and Septage Management (FSSM)

As per 2011 Census, in urban India approximately 51% of households are dependent on latrines with Onsite Sanitation Systems (OSS). The use of Onsite Sanitation Systems (OSS) can be a sustainable solution to meet sanitation goals in the urban areas of the country as long as there is effective Faecal Sludge and Septage Management (FSSM) along the entire Sanitation Service Chain. This would mean that the FSS generated from the OSS is regularly collected, transported, treated, and finally there is resource recovery or safe disposal of the treated waste water and the sludge as shown below in figure 1.

Figure 1: Sanitation value chain



	Containment	Emptying and transport	Treatment	Disposal and end use
Definition	An onsite sanitation system into which a user interface discharges	Manual or motorized removal and transportation of faecal waste from the containment system	Process of converting faecal sludge into a product that is safe for end use	Disposal or utilization of output products derived from sanitation systems
Examples	Septic tanks, soakpits and cesspools	Vacuum trucks or carts	FSTPs, constructed wetlands and dewatering	Manure

Source: Septage Management–A Practitioner's Guide, CSE

Box 1: Difference between sewage and faecal sludge and septage

Sewage vs. faecal sludge and septage (FSS)

Sewage is untreated wastewater that contains faeces and urine, this wastewater gets conveyed through the sewerage system. Generally, grey water from the kitchen and bathroom also becomes part of sewage. The BOD of sewage ranges from 150–350 mg/l and all sewage treatment plants are designed for this load to be taken into account. FSS is semi solid slurry, it is emptied out of on-site sanitation systems like septic tanks / pits and is much more concentrated than sewage; BOD of faecal sludge ranges from 1,000–20,000 mg/l.

There appears to be a very thin line between septage and faecal sludge. Septage is limited to septic tanks, and has already undergone partial digestion, whereas faecal sludge includes contents from other onsite technologies, including septic tanks, and may or may not be digested.

Under the Swachh Bharat Mission, around 30 million more septic tanks will be constructed by the end of 2019, which will be expected to produce 180 million litres of FSS every day. Due to lack of treatment facilities in the urban/semi urban areas of India, the cesspool vehicles that empty the septic tanks/pits of the households discharge the sludge either in open fields, drains or in water bodies. This results in the contamination of water sources like rivers, lakes and the ground water and ultimately leads to public health hazards thus, defeating the purpose of Swachh Bharat Mission. Unless due diligence is given to the treatment of this generated sludge, the sustainable sanitation and development goal would remain unfulfilled. Hence, the treatment of FSS is of paramount importance.

1.2 Introduction to co-treatment of faecal sludge and septage in STPs

The Environment (Protection) Act, 1986 and the Water (Prevention and Control of Pollution) Act,1974 prohibits effluent, sewage and septage discharge. Section-24 of Water Act informs that no person shall discharge any sewage or trade effluents beyond the standards as prescribed by CPCB into any stream, river, and well or on land.

As per the National Policy on Faecal Sludge and Septage Management (FSSM), 2017 issued by the Government of India, it is the responsibility of the ULB to 'set up and ensure operation of systems for 100% safe and sustainable collection, transport, treatment and disposal of faecal sludge and septage.' The policy further emphasizes on the importance of synergies between FSSM and sewerage systems through co-treatment of FSS in STPs.

For cities that are partially covered with a sewerage network, co-treatment of FSS in existing STP provides a cheaper alternative to treat the excreta generated from areas of the city not connected to the sewerage network. The additional laying out of sewer infrastructure for such areas would be costly and difficult to implement in densely populated areas. Setting up of a dedicated Faecal Sludge Treatment Plant (FSTP) might be more a time-consuming affair due to issues such as land identification and clearances needed for the same. Further, in case of co-treatment, the existing facilities, site infrastructure and manpower of the STP can also be used for co-treatment and thus, eliminate the problem of engaging a new O&M operator and additional cost related to site infrastructure. Thus, in scenarios where there is an existing sewage treatment plant with spare capacity, it would be prudent to undertake co-treatment of FSS in the existing STP.

Box 2: Definition of co-treatment

What is co-treatment?

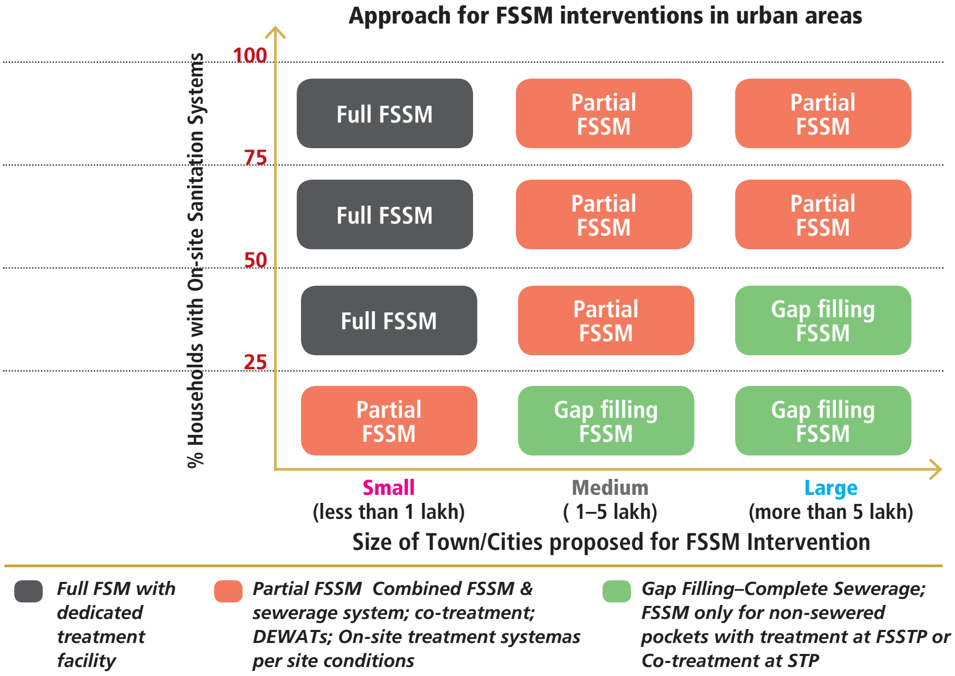
Co-treatment is a process where a Sewage Treatment Plant, in addition to treating the domestic sewage transported through a sewerage city, also treats faecal sludge and septage emptied from various Onsite Sanitation Systems prevalent in the city.

The current practice of co-treatment in India includes addition of faecal sludge in upstream of the STP either at a Sewage Pumping Station or at inlet of an STP. Practices in Malaysia, Philippines includes pre-treatment of faecal sludge before it is treated in the STP. The pre-treatment includes stabilization and/or solid–liquid separation whereby the separated liquid is treated in the STP and the separated solid are treated either in the existing STP drying beds or separate modules. By addition of pre-treatment modules, the capacity of the STP to treat faecal sludge increases as well as reduces the risk of process disruption and damage to the STP and/or sewerage network.

1.3 Planning for co-treatment in a city

Depending upon the percentage of dependency for Onsite Sanitation Systems and the size of the city, the approach for FSSM can vary from a complete FSSM approach, partial FSSM approach or a gap filling approach as highlighted below (Figure 2).

Figure 2: Approach for FSSM intervention in urban areas



Source: Managing Septage in cities of UP, CSE

Co-treatment of FSS in an STP would be an ideal treatment intervention for cities where partial or gap-filling FSSM is proposed. A dedicated FSTP can be supplemented with co-treatment depending upon the co-treatment capacity and the demand for faecal sludge treatment in the city.

The technical feasibility of co-treatment in an STP / sewerage system would depend upon many factors like coverage and capacity of the sewerage system, spare capacity of STP and its treatment efficiency, and the characteristics of FSS. Assessment of STP for co-treatment taking all these factors into account is discussed in subsequent chapters.

1.4 Assessing feasibility of co-treatment of FSS at an STP

1.4.1 Characterizing the FSS

Characterizing the FSS is an important part of the process for planning and studying the feasibility of co-treatment of FSS in an STP. The characteristics of the FSS such as the solids content, organic and nutrient load is much higher (up to 10 times) than sewage and is highly variable and dependent upon many local factors thus highlighting the importance of testing for characteristics of FSS.

Box 3: Sampling procedure—characterization of FSS in a city

Sampling procedure: To ensure representative characteristics of FSS for a city

The number of samples should be decided based on the size of the city. There is a need to ensure spatial as well as seasonal coverage of a city. The following protocols can be adhered to while taking samples for faecal sludge:

- Sample should be collected from the de-sludging vehicle at the discharging point. The source of the sample should also be recorded including the locality, type of containment system, period of de-sludging and the emptying procedure.
- Sufficient number of samples should be collected that is spatially and temporally spread such that the variability in the characteristics of faecal sludge is accounted for.
- Due to the variable characteristics of the faecal sludge, a composite sample should be taken instead of grab samples.
- While transporting the samples to the laboratory, care should be taken with respect to:
  - The sampling equipment should not react with the faecal sludge.
  - The samples should be preserved at an appropriate temperature.

The sampling activity should be properly documented, which should include proper labelling, chain-of-custody procedure and a logbook of sampling activities.

Refer section 4.3 of this report for detailed process followed by CSE Lab for collection FSS samples.

The following characteristics of FSS needs to be measured to determine the feasibility of co-treatment of FSS in an STP:

i. **Organic content and the biodegradability of FSS:** This can be measured by measuring the BOD_5, COD and its ratio. A COD TO BOD_5 ratio of 2 represents fresh FSS that is readily biodegradable whereas a higher COD to BOD_5 ratio (ranging 5 to 10) would indicate stabilized FSS. High organic content which is readily biodegradable would require additional modules for stabilization in order to make the FSS treatment in subsequent stages more effective.

ii. **Total solids content and its settling characteristics**: It is important to measure the total solids content in FSS. Solid–liquid separation is desirable for treatment of FSS with high solids content. Excessive solids accumulation in an STP based on aerobic process would lead to process disruption and may require more aeration. Settling characteristics of FSS would help to decide the methodology for solid-liquid separation (i.e. whether it is based on settling or pressure). Sludge Volume Index (SVI) is required to be calculated to help in determining the settling characteristics of the FSS.

iii. **pH:** Excessive deviation of pH from the norm may negatively impact the treatment of anaerobic process based STP.

iv. **Ammoniacal nitrogen and other nutrients**: Excessive ammoniacal nitrogen and other nutrients in present in FSS content may hinder the biological treatment of the STP based on anaerobic treatment. In certain STPs this may become a limiting factor. The ability of an STP to treat the additional nutrient load would have to be evaluated and accordingly the discharge of FSS in the STP would have to be restricted. Ignoring this factor would result in the effluent not meeting the discharge standards.

1.4.2 Evaluation of an STP

The key features of an STP to be analysed before undertaking co-treatment of FSS in the STP is as follows:

a) **The treatment process of the STP:** The treatment process of the concerned STP would need to be studied to determine the possible limiting factors affecting the treatment efficiency of the plant. In case of an aerobic system, oxygen requirement would be one of the critical limiting factors whereas in an anaerobic process, parameters such as pH and ammoniacal nitrogen would be important to ensure the biological process of the STP is not impacted by co-treatment.

b) **Spare capacity of the STP to treat additional FSS load:** In order to calculate spare capacity, the design capacity of the STP and the design sewage parameters should be known. By multiplying the design capacity of the STP and the designed BOD or COD load, the design Organic Loading Rate can be known in Kg (BOD or COD) per day. Similarly, the operational Organic Loading Rate can be arrived at by multiplying the operating capacity of the STP and the influent (BOD or COD) of the sewage received in the STP. The deficit between the Design Organic Loading Rate and the Operational Organic Loading Rate is the spare capacity of the STP.

Table 1: Illustrative example for calculation of spare capacity of STP

	Parameter	Value	Units
	Design parameters of STP		
(i)	STP capacity	10	MLD
(ii)	Design sewage BOD	300	mg/L
(A) = (i) x (ii)	Design organic loading rate	3,000	Kg (BOD)/day
	Operating capacity of STP		
(iii)	STP (Operating cap)	8	MLD
(iv)	Influent BOD	200	mg/L
(B) = (iii) x (iv)	Operational organic loading rate	1,600	Kg (BOD)/day
(C) = (A) - (B)	**Spare capacity:**	**1,400**	**Kg (BOD)/day**
(D)	**Influent FSS (BOD)**	6,000	mg/L
(C) /(D)	**Capacity of STP to treat FSS**	0.233 Or 2.3%	MLD or % of the design capacity of STP

c) **Existing Plant performance:** The treatment efficiency of the STP should be checked to ensure that the effluent meets the discharge parameters. Samples should be collected after each module of the STP to evaluate the corresponding changes in the characteristics of the sample. Samples should also be taken from the concerned aerobic and anaerobic reactors to evaluate the F/M ratio in order to determine whether the system can perform adequately. In case the existing STP is not performing adequately, co-treatment should not be recommended in such an STP.

d) **Availability of land:** Sufficient area should be available at the STP site for pre-treatment of the FSS before discharging into the STP. In addition to preliminary treatment like screening and grit removal and solid–liquid separation, sufficient area should also be available for treatment of the solids separated from FSS such that it can be safely disposed or reused.

e) **Distance of the STP from the city:** It is important that the STP is close to the city so as to ensure it is economically feasible for the de-sludging operator.

1.5 Example of co-treatment practices in India and abroad

1.5.1 Co-treatment practised in India

Co-treatment is an important option for treatment of FSS in the Indian context due to the fact that majority of the STPs in India are running below their design capacity and in majority of cases, the volume of FSS to be treated is less as compared to the treatment capacity of the STP.

Some of the current locations where co-treatment is practised in India are shown below in tables below.

Table 2: Examples of practice co-treatment of FSS in STPs in India

City	STP Location	Treatment approach	STP technology	Operation commenced	STP capacity (MLD)	Present FSS quantity (KLD)	Influent Sludge Volume (%)
Lucknow	Bharwara	Decanting of FSS at designated pumping stations	Upflow Anaerobic Sludge Blanket (UASB)	December 2017	345	20	0.00006
Kanpur	Bhingwan	Decanting of FSS within the STP premises	UASB	September 2017	210	315	0.0015
Ghaziabad	Indirapuram	Decanting of FSS at MPS and STP	Sequential Batch Reactor (SBR)	August 2017	56	250	0.004
Puri	Mangalaghat	Solid liquid Separation by Settling-Thickening tank	Aerated Lagoons	June 2017	15	15	0.001
Chennai	Nesapakka	Decanting of FSS within the STP premises	Activated Sludge Process (ASP)	July 2006	117	5,200	0.04
Goa	Tonca	Decanting of FSS just outside the STP premises	Cyclic ASP	Early 2006	12.5	720	0.05

(Source: MOUNT, CSE)

Table 3: Co-treatment scenarios in India: at STP inlet and sewage pumping station

Location		Description
Bingawan STP, Kanpur		The faecal sludge / septage is discharged at wells connected to the inlet of the STP.
Sewage Pumping Station, Ghaziabad		The faecal sludge / septage is discharged at well connected to the sump of the Sewage Pumping Station.

1.5.2 Potential detrimental impact of co-treatment practice in India

At all the places mentioned in the table above (except Puri), FSS is dumped into the pumping stations or at the upstream of the STP without any pre-treatment.

There are learnings from various countries on the detrimental impact of co-treatment of faecal sludge in an STP with any pre-treatment. The same are given below:

i. **Direct discharge of faecal sludge and septage in manholes or sewage pumping station or drains that lead the STP:**
   The considerably higher solids content of FSS may lead to severe operational problems such as solids deposition and clogging of sewer pipes. This is mostly because the diameter and slope of sewers are designed for the transport of municipal wastewater typically containing 250 to 600 mg TSS/L rather than the 12,000 to 52,500 mg TSS/L present in FSS. There is also the danger of corrosion of the sewerage infrastructure due to the high strength of the FSS as compared to sewage.

ii. **Direct discharge of faecal sludge and septage at the inlet of the STP**:
   - o Due to the high strength of faecal sludge and septage, even relatively small volumes can have a large impact on the organic, suspended solids and nitrogen loads on an STP. Possible consequences include:
   - ▪ an increase in the volume of screenings and grit requiring removal;
   - ▪ increased odour emission at headwork;
   - ▪ increased scum and sludge accumulation rates;
   - ▪ increased organic and nutrient loading, leading to overloading and process failure;
   - ▪ The potential for increased odour and foaming in aeration tanks.
   - o Because of their partly digested nature, faecal sludge and septage will

usually degrade at a slower rate than sewage and their presence is likely to have an adverse impact on the efficiency of treatment processes.

- The intermittent nature of faecal sludge and septage loading will give rise to high instantaneous loads and so amplify the problems identified above (Tayler, 2018).

1.5.3 Best practices of co-treatment/solid–liquid separation modules for faecal sludge treatment

The table 4 below, shows examples of co-treatment where modules for pre-treatment of FSS are added to an STP where the separated liquid is treated in the STP while the separated solids are treated separately.

Table 4: Best practices of co-treatment / solid-liquid separation of FSS

Location		Process / Technology
Septage treatment at Puri, Odisha, India		A Settling Thickening Tank (STT) is used to separate the solid and liquid. The supernatant from the STT is pumped to the existing STP based on WSP technology where the settled sludge is pumped to the existing STP drying beds.
Co-treatment at STP in Pantai, Kuala Lumpur, Malaysia	 Septage receiving station  Screw Press for S-L separation	The co-treatment mechanized solid–liquid separation modules (i.e. Screw Press). The separated liquid is treated in the STP and the separated solids is disposed off in a landfill.
Septage treatment at, Brgy. San Roque Baliwag, Bulacan, Philippines		The septage after the initial screening and grit removal uses a Screw Press for solid–liquid separation for septage. The separated liquid and solids are treated separately. The liquid is treated in a SBR treatment system.
Septage treatment Plant at Bakasi, Indonesia		Septage is received by a mechanized receiving station where after screening and grit removal, screw press is used for solid–liquid separation.

2. Lucknow—Assessment of excreta management

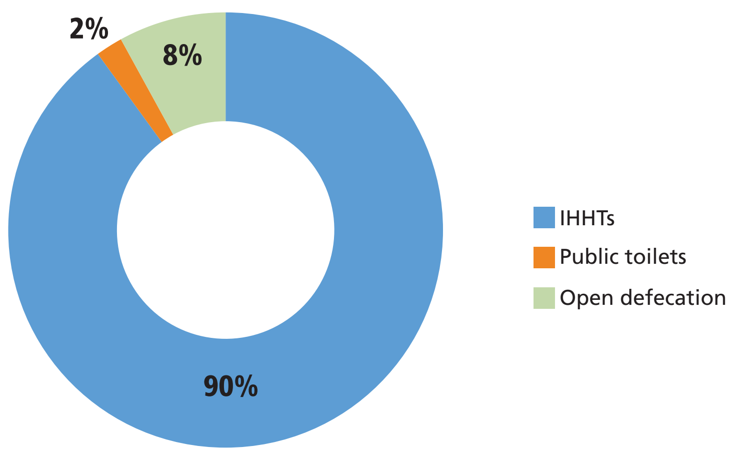
2.1 City profile

Lucknow, the capital city of the Indian state of Uttar Pradesh, is located in the central region of the state. It is situated at 26°30' & 27°10' N latitude and 80°30' & 81°31' E longitude. The city is spread to 348.8 sq.km with a population of 28.17 Lakh (512,519 households). The population density in the city is 8,077 persons per sq.km, which is higher than the average density of the state of Uttar Pradesh (828 persons per sq.km) but much lower than that of the national capital region (11,297 persons per sq.km). Lucknow city is situated on the bank of river Gomti—an alluvial river of the Ganga Plain, which divides the city into two parts—Cis-Gomti and Trans-Gomti.

Table 5: Demographics of Lucknow city as per census

Features	1991	2001	2011
Total Population	1,669,204	2,266,933	2,817,105
Area (sq. km)	337.50	337.50	348.80
Population density (per sq. km.)	4,946	6,717	8,077

Figure 3: Access to toilets in Lucknow



(Census 2011)

2.1.1 Access to toilets

As per Census 2011, 90.2% of the households in Lucknow had access to Individual Household Latrines (IHHLs) while 2.5% were dependent on public toilets (PTs) and community toilets (CTs) (Figure 3). Further, around 7.5% of households lack access to any kind of sanitation facilities and were defecating in the open.

2.1.2 Sewage collection and conveyance system

As per Census (2011), 54.2% of households were connected to piped sewer while the remaining 36% were connected to Onsite Sanitation systems (OSS) including septic tanks (32.4%). Further as per talks with officials from Lucknow Nagar Nigam and UPJN, there are 33 open drains that carry storm water and all kinds of wastewaters. Out of 33 drains, 26 drains are intercepted and the remaining 7 drains let all untreated wastewaters flow into Gomti River.

2.1.3 Sewage treatment facilities

There are two STPs in Lucknow with a total installed capacity of 401 MLD, which are currently handling a load of 415 MLD. Table 6 gives broad details about the STPs in Lucknow.

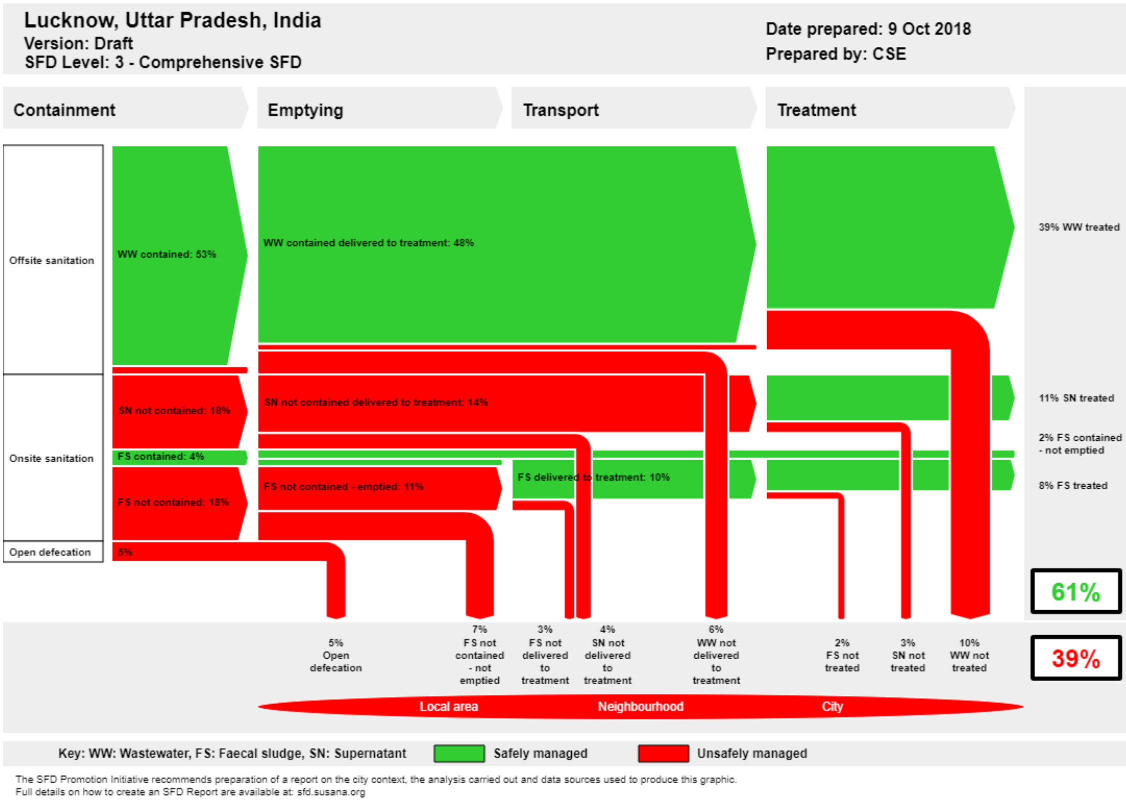
Table 6: Details of existing STPs in Lucknow

STP	Design Capacity (MLD)	Inlets	Quantity of sewage received from each source (MLD)	Total quantity of influent (MLD)	Remarks
Bharwara	345	• 22 drains • 837 km sewer	250–260 80–90	350	Treating 5MLD (1.5%) more than its design capacity
Daulatganj	56	• 4 drains • 339 km sewer	30–35 25–30	65	Treating 9MLD (16%) more than its design capacity

Source: KII with UPJN officials

2.2 CSE's assessment of excreta management in Lucknow

Figure 4: SFD of Lucknow city



Source: CSE, 2018

A Shit (or Excreta) Flow Diagram was prepared for Lucknow by CSE after a detailed study of the city. The diagram shows the percentage of population whose excreta is safely managed across the sanitation value chain. From the diagram we can see that the excreta generated by 61% population of the city's is safely treated (shown in Green) however, **excreta generated by 39% of the population is not safely treated (shown in Red).**

However, it may be noted that all the 61% of the FSS shown as safely managed in the SFD are discharged at the nearest SPS or drains leading to SPS. The possible detrimental impact of uncontrolled discharge of FSS in SPS could have long-term damaging impact on the sewerage network and the pumping station with issues such as clogging and damaging of pipes.

Box 4: Case for co-treatment in Lucknow

The SFD study shows that 47% of the households in Lucknow are dependent upon Onsite Sanitation Systems. There is a functioning sewerage network with two operational STPs. A gap-filling FSSM approach with co-treatment of FSS in the existing STPs would be a viable approach. This intervention would significantly reduce the unsafely managed excreta as shown in the SFD as well as reducing the risk of potential detrimental impact of FSS on the pumping stations, sewerage network and the STPs.

2.2.1 Results from study of city-wide sanitation in Lucknow

An overview of the finding from CSE's study about the present scenario of the sanitation value chain in Lucknow is presented below:

a) Containment:

The sewerage network is available to more than half of the population of the city and the rest is largely dependent on onsite sanitation systems (OSS). Only a scant population practices open defecation. Currently, there are many areas where the sewer line has already been laid, but the sewers are yet to be connected to their respective STPs.

Customarily, the population dependent on OSS have constructed either septic tanks or fully lined tanks (with and without outlets), lined tanks with open bottom or unlined pits (locally called as *sokhta gaddha*). Any kind of lined tanks (with outlet) connected to toilets are locally called septic tanks irrespective of whether it adheres to the design specifications prescribed by Bureau of Indian Standards (BIS), or not. Due to lack of standardization of containment systems and absence of enforcement of BIS code for septic tanks, it was observed that few households have constructed extremely large containments systems, which would not need emptying for at least 10 years. However, such a containment system would potentially contaminate the ground water in the locality.

Figure 5: Under construction septic tank in Lucknow

Figure 6: Septic tank of a public toilet

Source: CSE 2018

b) Emptying
Emptying frequency differs widely across the city, depending upon the type of OSS. Containments, which do not have outlet, have an emptying frequency ranging from 6 months to 1 year, whereas the emptying frequency of systems with open bottom increases to 12–15 years.

LNN owns and operates 10 vacuum tankers and 6 truck jetting and sucking machines of which tractor mounted have a faecal sludge carrying capacity of 3000 litres capacity. The emptying fee per trip charged by the LNN for 3,000 litres capacity tankers is ₨ 1,500. On an average, these tankers cumulatively complete 2–3 trips per day, monsoon being the peak season for emptying.

As per discussion with LNN officials, there are 35 private vacuum tankers plying in the city, of which 13 are registered with the LNN. The faecal sludge carrying capacities of these trucks varies between 5000–6000 litres and the fee charged by them ranges from ₨ 800–₨ 4000 per trip.

Figure 7: LMC owned vacuum tanker emptying containments of households

Source: CSE 2018

c) Transportation
Sewage from the sewer network is pumped from Sewage Pumping Stations (SPSs) to the Sewage Treatment Plants (STPs). For effective planning, implementation and maintenance, the UPJN has divided the whole city into four sewage districts. Faecal sludge and septage are conveyed through truck/tractor mounted vacuum tankers (figure 8). Average distance covered by the emptiers per trip is about 5–6 km. The supernatant generated from containment (septic tank / fully lined tank) connected to open drains, is transported through lined open drains. These small drains eventually cover to form big drains and there are a total of 33 big drains (locally called *nullahs*) in the city. Out of the total 33 big drains, 26 are eventually intercepted by the sewerage network and the rest discharged directly into River Gomti.

Figure 8: Private registered emptier

Source: CSE 2018

d) Treatment and end-use/disposal

It was observed during the survey that households discharge their wastewater into the sewerage network but in the absence of complete trunk sewers, the sewage flows into open drains and ground, which are eventually intercepted by SPSs and pumped to STPs. There are a total of two STPs in the city with cumulative sewage treatment capacity of 401 MLD. Treated sewage from the STPs is discharged into Gomti River. The treated sludge from the STPs is used in landfilling and is given to the nearby farmers for no cost, at present. There are no set protocols / procedures for safe disposal of treated sludge or its end use.

Figure 9: Private operator discharging FSS in open ground

Figure 10: Inlet of STP at Bharwara

Source: CSE 2018

3. Assessment of Bharwara STP (Lucknow) for co-treatment

3.1 Bharwara STP: Overview

3.1.1 Introduction

Bharwara Sewage Treatment Plant (STP) is located at Bharwara in Gomti Nagar, Lucknow. It is touted as Asia's largest STP. Its operation commenced in 2011.

3.1.2 Details of STP

STP at Bharwara is based on Upflow Anaerobic Sludge Blanket (UASB) Reactor technology and is spread across 120 hectares area. The block diagram of the technological components involved is shown below in **Figure 12.**. The technical specification of each component is provided in Annexure 1.

The sewage at the inlet of the STP comes from the Main Pumping station located at Gwari. The inlet of the STP is divided into 3 distribution streams A, B and C as shown above in Figure 11. Each has a capacity of 115 MLD. From the inlet, the wastewater flow through mechanical screens, which are two in number and one manual screen, is on standby. The coarse matter is trapped in the screens. Next in line is grit chamber, which is used to trap the grit material. The trapped grit is removed from the channel via an outlet situated at the end of the chamber.

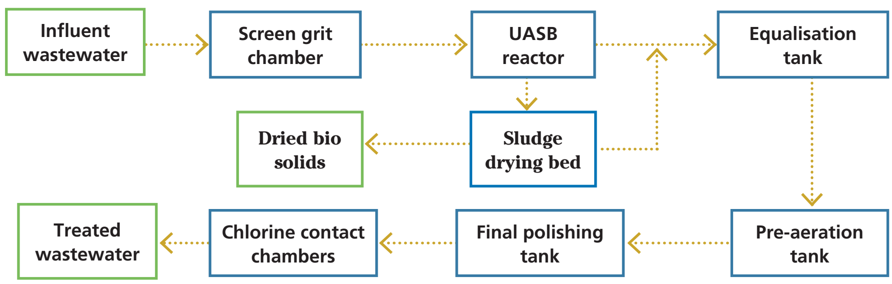
Figure 11: Aerial view of Bharwara STP

Source: UPJN

The wastewater then flows to Upflow Anaerobic Sludge Blanket (UASB) reactors. UASB is an anaerobic process whilst forming a blanket of granular sludge that suspends in the tank. Wastewater flows upwards through the blanket and is processed (degraded) by the anaerobic micro-organisms.

The end product of the process is biogas, which is stored in gas chambers and is currently being flared into the atmosphere. The sludge generated from the reactor is sent to sludge pumping station and from there it is being pumped to sludge drying beds. The treated wastewater from the UASB reactor is then taken to pre-aeration tank where the wastewater is aerated with the help of surface aerators. Each tank has one aerator. From the pre-aeration unit, treated wastewater is then taken to final polishing pond where the wastewater is kept for 24–48 hours. From final polishing pond, the treated wastewater is taken to chlorine contact chambers. Here the water is chlorinated, which kills the pathogens present in the water. Finally, the water is released from outlet of the STP.

Figure 12: Block diagram of Bharwara STP



Source: UPJN KII & CSE Field Visits

3.1.3 Operational performance of the Bharwara STP during site visit

A site visit was undertaken by CSE in the presence of the Project Manager UPJN to understand the current functioning of the STP. Observations from the site visit by CSE and KII with UPJN officials and site operators are as follows:

- The STP was found to be in operation on the day of monitoring.
- The STP has three channels each of 115 MLD. The channels are fed by the Gwari pumping station in Gomti Nagar drawing sewage from two subsidiary pumping stations each situated on two major canals–Kukrail canal (Balkuuthdham PS having capacity of 190 MLD, six pumps–1000HP / 1700 lips) and Ghiasuddin Haider canal PS (158 MLD).
- There are 22 drains which are connected to the STP. There are seven drains, which are yet to be trapped and taken for treatment. At present, the sewage from these seven drains goes to river Gomti untreated.
- The STP has six numbers of screen (mechanical) as sewage is divided into three channels. Each channel has two sub-channels. Manual screens as standby installed the same purpose.
- Six Grit chambers for removing grit particles were installed. Each channel has two grit channels.
- It was informed that grit particles collected during primary treatment of sewage were disposed-off as filler material in low-lying areas.
- The STP has installed electromagnetic flow meters for measurement of sewage flow in each channel (three) at the inlet and records maintained.
- Secondary treatment of sewage was done by providing the UASB reactors. The STP has 30 reactors and each reactor has 11.5 MLD capacities.
- The gases generated during the treatment process in the UASB reactors are stored in the three gas holders.

- About 30–35 cum per hour biogas is generated presently.
- Total 60–65 MT dry sludge generated during treatment in the UASB reactors was received by the SDBs and it was sent to farmers for utilizing in agriculture activities. There are 106 SDBs.
- The sludge generated by the STP is given to farmers for free. However, no record is being maintained regarding the amount of sludge given to farmers.
- The treated water from UASB is collected in pre-aeration tanks for further treatment.
- Pre-aeration tank had 18 surface aerators installed. The aerated water was further received by aeration tanks (six) where three floated aerators of 30 HP capacity were installed in each aeration tank.
- The STP has polishing ponds (three) for enhancing the quality of treated water.
- The STP has installed chlorination treatment for removal of harmful bacteria from the treated water.
- The chlorination system has the booster pump with capacity 20 m3/hr at the rate of 06 kg/cm2. The chlorination was carried out in the chlorination contact tank.
- The STP has neither the on-line continuous monitoring system nor electromagnetic flow meter at final discharge of STP.

The test report of the STP effluent conducted by UPJN lab is attached in Annexure 1. The report shows an average influent BOD, COD and TSS of 140 mg/l, 275 mg/l and 230 mg/l respectively. The treated effluent meets the previously notified discharge standards of BOD 30 mg/l and TSS 50 mg/l to water bodies. However, the STP does not meet the current notified standards set by the National Green Tribunal (NGT). Through visual analysis during the site visit, it was observed the UASB reactor might not be working efficiently. Foam formation was observed in the effluent from the UASB reactor. This might be because of the low sludge retention time in the UASB reactor. Currently, sludge is removed from all the three positions (top, middle and bottom) regularly after two days, which might be affecting the efficiency of the UASB process. Highly active sludge at the bottom mainly responsible for biodegradation of organics is removed thus rendering the entire UASB process ineffective. Another possible reason might be the presence of Fats, Oil & Grease (FOG) in the influent.

Even though Bharwara STP is working at full capacity, co-treatment is still feasible because:

- The FSS (20 KLD in present FSS quantity) introduced into the STP system is negligible as compared to the capacity of the STP (345 MLD). The influent sludge volume is 0.006% of the STP capacity.
- The influent sewage received at the STP has low BOD and COD i.e 140 mg/l and 275 mg/l respectively as compared to traditional raw sewage. One possible reason for this is that significant amount of STP influent is received from tapping nullahs. Therefore, even the high COD and TSS of FSS would be diluted by the sheer volume of influent sewage with low COD, which does not affect the normal functioning of the STP.

Even though co-treatment is feasible at present loading conditions, future loading conditions would also have to be kept in mind and the characteristics of STP influent and effluent monitored regularly.

Figure 13: Foam formation after UASB reactor in Bharwara STP

Source: CSE field visit December 2018

Box 5: Way forward—Improving existing STP treatment efficiency

Action Plan to improve the existing STP treatment efficiency

1. Study to evaluate STP efficiency
   a. Wastewater samples should be collected from influent and effluent of each module of the STP to evaluate how each module is working.
   b. Samples from the UASB reactor can be taken to measure key parameters like pH, Ammoniacal Nitrogen content and F/M ratio in order to ascertain whether optimal conditions are being maintained in the reactor for effective biological treatment.
2. Suggested interventions
   a. Maintain the sludge retention time in the UASB reactor to at least 2–4 weeks. Currently, it was found to be maintained only for 1–2 days.
   b. Installation Fats-Oil-Grease treatment unit at the inlet of the STP.
   c. An additional unit or increase aeration and retention time in the treatment modules subsequent to the UASB reactor. This would be needed to ensure the revised effluent parameters set by the NGT are met by the STP.

3.2 Existing co-treatment initiatives in Lucknow

The main driver for initiating co-treatment was the fact that private de-sludging operators were dumping septage into Gomti River / open areas / drains and LNN decided to stop this unauthorized dumping and stem the resultant river pollution. A directive of the National Green Tribunal (NGT), regarding the need to arrest pollution of the region's water bodies, was another factor that prompted firm action from the local body. Further, the inclusion of co-treatment as one of the parameters in the Swachh Survekshan (2018) was an incentive for LNN to implement co-treatment in order to improve the city's overall score and the resultant national ranking.

Simultaneous to the initiation of co-treatment facility, LNN undertook strict enforcement of the NGT's directives and provisions of the Swachh Bharat Mission (SBM). A notification was published by the LNN (refer Annexure 1) in all leading newspapers about making it mandatory for all private de-sludging operators to register with LNN and decant the Faecal Sludge and Septage (FSS) at designated points, which included existing Sewage Pumping Stations (including intermediate and main). Penalties amounting to INR 10,000 were imposed on private de-sludging trucks found disposing FSS unsafely. This twin strategy of strict enforcement of environmental pollution control laws along with making provision of decanting facility helped LNN ensure that private de-sludging operators operating in the city were registered with the local body. The process of registration of private de-sludging operators was initiated in September 2017 and at present, six operators which have 13 trucks collectively, have registered with LNN. Vehicles used for de-sludging are trucks mounted with suction pumps and tanker with capacities ranging from 4000–5000 litres.

At present, there are presumably 35 private vacuum tankers plying in the city each with a capacity of 4000–5000 litres. Each tanker makes around 1–2 trips per day. The tankers cover a distance of 10–12 km per trip and the average time taken to empty and decant is 01–1.5 hours.

3.3 Possible detrimental impacts of existing for co-treatment practice on Lucknow's sewarage system

Currently in Lucknow, FSS is directly discharged into the existing sewage pumping stations. It is the most convenient and economical approach from the point of view of collection and transportation. However, the present practice of discharging of the FSS in the SPS in Lucknow is being done in an uncontrolled manner. The characteristics of FSS are highly variable, as already mentioned in the previous chapters, with parameters being up to 10 times higher than sewage.

The sewerage infrastructure and the existing STPs are not designed to handle characteristics of a typical low or high strength FSS. The uncontrolled discharge of FSS either in the sewerage network or in the STP can have damaging effects on the existing infrastructure which can include:

1. Clogging of pipes with excessive solids.
2. Corrosion of pipes and other infrastructure related to the sewerage network
3. Process disruption of the existing STPs as already discussed in the previous chapters.
4. Increase in the O&M requirements associated with frequent de-sludging, higher aeration requirement at the STPs.
5. Reducing the overall useful design period of the sewerage infrastructure and STPs.

It is recommended to study the characteristics of FSS in the local context and explore possible options of pre-treatment modules before FSS is discharged into the STP.

4. Characteristics of Faecal Sludge and Septage (FSS)

Faecal Sludge and Septage characteristics are highly variable as it depends on several factors such as the type of containment unit (septic tank, pits), de-sludging frequency, techniques of de-sludging, temperature soil characteristics and ground water table in a city etc. In general, FSS is generally much more concentrated than sewerage around 10–100 times higher in organic pollutants and suspended solids. Some of the common factors that determine the characteristics of the FSS are shown in the box below.

Box 6: Factors affecting characteristics of FSS

Factors affecting FSS Quality and characteristics variability

1. **Source of FSS and toilet usage:** The household habits associated with toilet usage affects the FSS quality, for example, dry versus flush toilet, volume of water flushed, and inclusion of grey water from kitchen and bathroom, addition of solid waste. It has been observed septic tanks in hotels and restaurants tend to have more oil and grease since the waste water from the kitchen is often connected to the septic tank.
2. **Type of Containment and storage duration:** The storage time in the pit or tank determine the degree of digestion that would occur. In general, the FSS would be less digested or stabilized (because of shorter shortage time); it therefore, may require an additional treatment step such as a bio digester as compared to the sludge from septic tanks or pits. The emptying frequency of septic tanks varies greatly based on the volume and number of users, and can be anywhere from weeks to years. FSS that has been stored in a septic tank for a period of years will have undergone more stabilization than FSS from public toilets.
3. **Emptying Method:** During the filling of onsite containment systems, the FSS gets denser at the bottom due to compaction. This FSS is more difficult to remove by pumping, and is therefore, frequently not emptied and left at the bottom of the containment system. In cases where they are emptied it will either require mechanical / manual interventions or adding water to decrease the viscosity and enable pumping. Pit latrines which are unlined or partially lined also frequently require flushing with large amounts of water in order to pump the FSS, as liquid leaching from the pit increases the thickness of the FSS. FSS that has been removed by pumping is generally more dilute and less viscous than FSS that is manually collected.
4. **Climate:** It has a direct influence mainly due to temperature and moisture. In regions of high rainfall, frequent de-sludging is required and the sludge collected will be more diluted. The rate of degradation also increases with an increase in temperature.
5. **Inflow and infiltration:** The permeability of containment systems is influenced by whether they are unlined, partially lined, completely lined, connected to drainfields or soakpits, and the quality of construction. If systems are permeable, the amount of inflow and infiltration will be influenced by the type of soil and the groundwater level. This would have an impact on the characteristics of the faecal sludge.

4.1 Typical characteristics of FSS

The characteristics of FSS are highly variable due to the factors mentioned above. Heinss et al (1998) in a paper presented a comparison of characteristics of fresh FSS and partially digested FSS. The values were based on a study done previously in Accra (Ghana), Manila (Philippines) and Bangkok (Thailand).

The characteristic of fresh and digested / stabilized FSS and sewage is given in the table below.

Table 7: Characteristics of FSS and comparison with tropical sewage

Item	Type 'A' (Fresh FSS)	Type 'B' (Partially Digested FSS)	Sewage
Example	Public toilet or bucket latrine sludge	Septage	Tropical sewage
COD (mg/l)	20,000–50,000	<15,000	500–2,500
COD/BOD	2:1–5:1	5:1–10:1	2:1
NH4-N (mg/l)	2,000–5,000	<1,000	30–70
TS (mg/l) (%)	≥ 3.5	< 3	< 1
SS (mg/l)	≥ 30,000	≈ 7,000	200–700
Helm. eggs, (no./l)	20,000–60,000	≈ 4,000	300–2,000

(adapted from Heinss et al., 1998)

The table above shows huge variation in the characteristics of FSS due to the factors, which have already been discussed. Thus, in addition to characterization of FSS as fresh and partially digested, FSS can be further classified into low strength, medium strength and high strength depending upon their COD, TN and TSS characteristics as shown in the table 8 below:

Table 8: Characteristics of Feacal Sludge

Sludge Type	Fresh			Digested		
Strength	High Strength	Medium Strength	Low Strength	High Strength	Medium Strength	Low Strength
COD (mg/L)	250,000	65,000	10,000	90,000	45,000	3,000
TN (mg/L)	5,000	3,400	2,000	1,500	400	200
TSS (mg/L)	100,000	53,000	7,000	45,000	25,000	1,500

(Dangol, 2013; Hooijmans et al., 2013)

4.2 Tests of FSS samples in Lucknow by UPJN

UPJN undertook testing of FSS at its laboratory at the Bharwara STP in December 2018. The sampling protocol and equipment used to test wastewater samples were used for this testing. The samples were taken from the Main Pumping Station (designated disposal site for registered de-sludgers). The locality from where the sample was received was being recorded; however, the typology of containment system and establishment was not recorded. The results of the samples tested by UPJN at Lucknow are shown below.

Table 9: FSS characteristics in Lucknow

Location	pH (mg/L)	DO (mg/L)	TSS (mg/L)	COD (mg/L)	BOD (mg/L)	BOD/COD
Khargapur	7.76	Nil	25,006	20,800	6,500	0.3125
Lakshmanpuri	7.80	Nil	7,204	3,200	1,650	0.5156
Abrar Nagar	7.69	Nil	14,300	7,900	2,150	0.272
Harihar Nagar	7.90	Nil	39,400	27,500	7,000	0.10
Indira Nagar	7.54	Nil	15,760	6,160	2,850	0.462
Takrohi	7.32	Nil	27,125	8,750	5,500	0.628
Vibhuti Khand	7.18	Nil	86,600	36,000	7,700	0.214
Harihar Nagar	7.18	Nil	23,500	7,800	3,100	0.397
Thakurganj	7.36	Nil	22,500	7,500	2,100	0.280

Source: UPJN

4.3 FSS testing and sampling protocols at CSE laboratory

Although we get a fair idea of chemical and biological characterization of FSS from already published texts, research papers worldwide, which have also been referred to in previous chapters, CSE decided it would be prudent and wise to initiate a first-of-its-kind India-specific study wherein FSS samples from the vast geography of India shall be collected, analysed and eventually, the findings shall be published. Relevant stakeholders can make an informed choice on which treatment technology is to be adopted. As part of this study, cities including Bijnor and Chunar from Uttar Pradesh were selected which are located at the extreme ends of the state and would be ideal to understand the variability of FSS characteristics in the state.

The sampling methodology followed by CSE include:

- **Planning for sampling:** Finalizing the geographical reach, timing of sample pickup and study duration, number of samples and parameters to be measured, types of containment and establishments that the systems are catering to are known and recorded.
- **Preparation of sampling kit:** Personal Protective Equipment (PPEs), collection bottles, labels and marker, sampler, bucket and ladle, icebox and pH portable meter or pH measuring strips, colour chart and thermometer are the materials that need to be carried for sampling and use, according to the pre-defined protocols and procedures.
- **Trained manpower:** An experienced staffer is always there to lead a sampling exercise while others may accompany him or her as trainees. Prior to sampling, an internal briefing takes place at the CSE laboratory so that people are on the same page. If they are in the team, a junior staffer may be given the task of getting questionnaires filled up from property owner and the emptier.
- **Collection of samples:** Steps involved and followed while collecting samples from the discharge point of the de-sludging vehicle include:
  i. Reach the outlet point of the tanker and open up the drain valve gently. Now one can start collecting the out-flowing sludge as per the time intervals calculated using the procedure explained below.
  ii. ‘t’ is an equal interval of time that we calculate prior to the sample collection. So, if there is a truck that takes T = 10 minutes to drain completely, then ‘t’ = 2.5 mins for ‘n’ (number of samples) = 5
  $t = T/(n-1)$

Hence, value of t depends on the total drainage time of the truck and number of samples to be mixed together to make a composite sample

iii. Periodicity of sample collection: -
‘0’ minutes (at the beginning)
‘0 + t’ minutes (2.5 mins)
‘0 + 2t’ minutes: (5 mins)
‘0 + 3t’ minutes: (7.5 mins)
‘0 + 4t’ minutes: (10 mins, at the end)

An error in timekeeping of ± 10 seconds is acceptable while doing this exercise.

iv. The mix of these 5 samples is then churned using a ladle and poured into a bottle. It is considered representative of the load that the tanker extracted from the septic tank/ABR /containment.

Steps involved in sampling with the core sampler are given below (for samples taken directly from containment):

i. Assemble the core sampler at the site. The height can be adjusted (if extendable), as per the site requirements.
ii. The sampler should be high enough to sample the full vertical section of the sludge standing in the containment.
iii. The joint should be made with a rubber washer inserted between the two sections to prevent any leakage of sludge/liquid.
iv. One should put it vertically inside the tank and push it through gently to the bottom layers where it’ll come to rest softly against the floor. If pushed too fast, it may result in splashing, air pockets and breakage due to impact.
v. After the sampler is filled up with the sludge, water and scum, the sampler should be retracted back vertically and upturned into a bucket or container. From there, an appropriate sample volume can be taken out.
vi. Sample taken this way is a more representative one with all layers accounted for, in correct proportions.

- **On-site Testing:** After the sludge sample is collected using either of the above two methods, there are a certain number of basic on-site tests that can be performed on the samples that includes pH, containment temperature, odour and colour.
- Work after sample lifting and on-site testing: After the sample collection and on-site testing are completed, the leftover composite sample can be safely disposed off at the designated discharge point. pH value can be measured for the composite sample that has just been stored in the sterile container. Thereafter, all the equipment such as sampler, bucket, ladle etc. is to be washed with clean water and soap, before being secured in a storage bag. The gloves should be secured in a bio-hazard bag and disposed off suitably.
- Sample preservation: Preservation of the sample is imperative for getting analytical results that can be trusted. Since sludge characteristics are transient, it is very much important to get them to the laboratory as quickly as one can, to start the analysis. CSE’s laboratory has sampled at sites close to its home base and at sites that are more than a thousand kilometers away. In both scenarios, sample preservation methods differ.

At sites where travel time is a few hours, samples are put in an ice box with frozen ice gel packs that keep the inside temperature close to 1 ºC ~ 4 ºC. After arrival, they are immediately set for processing.

At sites where travel time is over 12 hours and sometimes could even take more than a day, samples are put in an icebox with chunks of dry ice. This situation may not be ideal, but at least ensures that microbial activity and degradation is arrested and the samples stay as they are.

4.4 Tests and results from FSS samples in Chunar and Bijnor by CSE

CSE collected samples in the cities of Chunar and Bijnor on January 2019 and February 2019 respectively, following the strict process and protocols mentioned in the above section. The samples were collected at the discharging point of the de-sludging vehicle. The information related to the source of the FSS was also recorded.

Figure 14: FSS sample collection from Bijnor and Chunar, respectively

(Source: CSE laboratory)

The results from the tests conducted by CSE on the samples collected from Bijnor and Chunar are shown in the tables below.

Table 10: FSS Characteristics in Chunar

Location	pH (mg/L)	Moisture Content	TS (mg/L)	COD (mg/L)	BOD (mg/L)	COD/BOD
Jal Kal campus	6.6	96.7	32,160	67,950	5,800	11.7
Primary health centre	6.8	96.6	40,400	71,700	3,790	18.9
Kanshiram Awas Colony	6.2	94.8	30,500	72,300	5610	12.9
Community toilet	6.8	95	60,960	100,800	3,730	27.0
Public toilet	6.6	99.1	17,360	31,800	2,960	10.7
Radiant International School	6.5	96.3	31,000	53,100	3,260	16.3
Composite sample	6.6		44,960	59,400	-	

(Source: CSE Lab)

Table 11: FSS characteristics in Bijnor

Location	pH (mg/L)	Moisture Content	TS (mg/L)	COD (mg/L)	BOD (mg/L)	COD/BOD
Hotel Chetali, Taimoorpur	6.5	98.1	50,328	32,600	4,800	6.8
Household–Railway colony, Rashidpur Garhi	7.2	99.2	25,360	20,550	1,380	14.9
Household– Mukarpur Khema	6.5	84.3	118,348	72,300	5,430	13.3
Household–Valmiki basti	7.3	96.7	31,398	120,100	4,630	25.9
Household–Jyothi Nagar	7.5	93.0	34,388	35,900	2,420	14.8
Krishna College	7.2	99.4	1,278	1,040	870	1.2
Household– Faridpur	6.8	94.2	42,264	45,550	1,640	27.8
CT-Ravidas Nagar	6.9	99.2	2,638	6,200	630	9.8
District Hospital, Rambagh	7.4	98.9	9,766	16,200	1,258	12.9
District Magistrate Residence, Sadar Bazar	7.8	93.4	79,622	71,950	3,850	18.7
Household–Awas Vikas colony, Islampur Das	7.5	96.4	41,424	49,300	3,010	16.4
Composite sample	7.2	98.1	27,594	37,900	2,690	14.1

(Source: CSE laboratory)

COD to BOD ratio is the measure of FSS susceptibility to biodegradation: the higher the ratio, the more refractory matter it contains. Both in the case of Chunar as well as Bijnor, the COD to BOD ratio is consistently over 10 which means substantial stabilization has already undertaken in the FSS, and it is not really biodegradable.

As already mentioned characteristics of the FSS are highly variable. Huge variations can also be seen in the COD and BOD values from testing done on samples from Bijnor and Chunar by CSE as well as testing done by UPJN on FSS samples in Lucknow.

Considering the huge variation in the BOD and COD level observed in the samples, it is considered prudent to map out a scenario analysis of low-strength, medium-strength and high-strength influent FSS and study the impact on treatment efficiency of the STP. The COD varies from 6,000 mg/L to 120,000 mg/L.

5. Technology options for co-treatment in an STP

5.1 Different options for co-treatment

Objective:
The characteristics of FSS are highly variable as already discussed in previous chapters. The main points of concern are the high organic content, solids, nutrients and pathogens. The main objective of treatment of FSS is:

1. Liquids–to bring down the organic, nutrient loads, total solids and pathogens in compliance with the CPCB discharge norms or appropriate norms based on the re-use or discharge into the environment.
2. Solids–to make it suitable for re-use or safe disposal by:
   a. Bringing the total solids content of FSS upto 25–30% such that it can be handled as a solid.
   b. Removing pathogens.

Approach for Treatment of FSS:
While deciding to undertake co-treatment of FSS in a STP, it is important to evaluate the existing characteristics of FSS (total solids, organic load and nutrient load), operational capacity of the STP and the treatment technology of the STP. Total solids content is an important parameter in accessing the pre-treatment option for undertaking co-treatment in STP.

Preliminary Treatment:
It is advised that the FSS must undergo some type of preliminary treatment that may include screening, grit removal and the removal of fat, oil and grease depending upon the characteristics of FSS. This is needed in order to avoid process disruption and clogging of the STP pipes due to excess solids or trash in raw FSS.

In cases where significant quantity of fresh FSS is received at the plant, a stabilization unit can be added during preliminary treatment. This will help in the ease of treatment in the further units, the settle the solids in FSS and aid the further de-watering, which might be required for re-usability of the treated solids.

Co-treatment of FSS in an STP
After the preliminary treatment, there are various options for co-treatment of FSS in STPs. The options can broadly be categorized into two approaches:

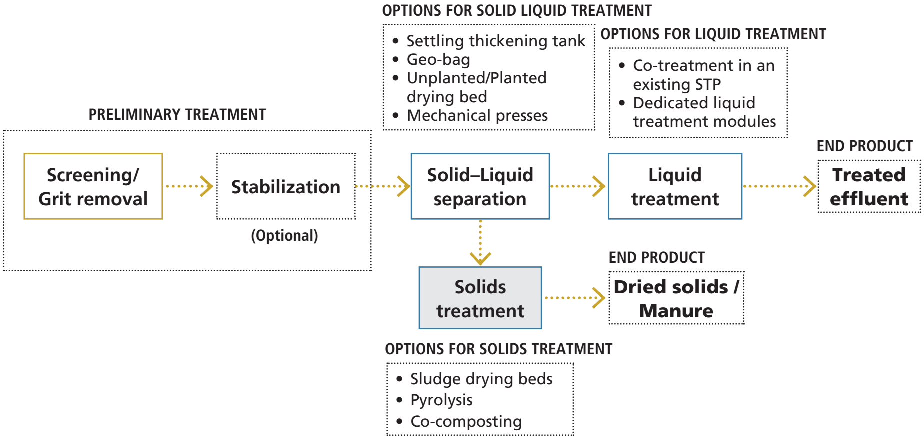
1. **Direct discharge of FSS:** This approach includes controlled discharge into the existing STP. This should ideally be done after preliminary treatment and homogenization. This would only be suitable for faecal sludge with solids contents less than or equal to 1% and after checking the spare capacity of the concerned STP with respect to the operational Organic Loading Rate (OLR) and Hydraulic Loading Rate (HLR).

   Depending upon the distance of the STP from the city, authorities might opt for discharge of FSS at the nearest STP or SPS or a sewerage network manhole. However, such initiatives should be done with caution. Since the sewerage network is not designed for the high strength and solid contents associated with FSS, there are chances of clogging and corrosion of the pipes.

2. **Provide solid–liquid separation unit**: The unit could be gravity based or mechanical based. The liquid part is treated in the existing STP while the solids can be treated in the sludge drying beds of the existing STP or separate units. This is suitable for FSS with solids content of at least 1% or greater.

In case it is decided to undertake solid–liquid separation, (Figure 15) shows the various stages of treatment of FSS and the technology options for the same.

Figure 15: Treatment options for FSS



Adapted from Tayler, 2018

Options for solid–liquid separation:
Providing a solid–liquid separation unit is important for co-treatment of FSS in an STP due to the following reasons:

1. The existing STP is not designed for high solids and organic fractions present in FSS. Most of its non-biodegradable COD is associated with particulate matter, as is its non-biodegradable COD. Removal of this material from the liquid flow will render the liquid more amenable to treatment (Tayler, 2018). The solid–liquid separation unit helps in reduction of the organic and suspended solids load in the liquid fractions and thus reducing risk of process disruption in the existing STP and also reduces the problems associated with excessive solids getting accumulated in the STP.

2. Reduce water content of the separated solids and thus aid the subsequent modules to be used for de-watering for end-use or safe disposal.

Solid–liquid separation can be achieved through settling by gravity, filtration, evaporation, evapotranspiration, use of pressure or centrifugal movements. Depending upon the solids content of the inlet FSS, the following solid–liquid separation techniques may be preferred:

i. FSS with solids content between 1–5%:

a) Settling thickening tanks:
The settling thickening tanks works on the principle of settling through gravity. Fresh FSS should be stabilized before introduction in this module. This option requires an active sludge management as the settled sludge needs to be removed periodically (typically in the range of 3–10 days). The separated sludge normally has solids content in the range of 4–10%, contains pathogens, and hence requires further treatment for safe disposal or reuse.

Figure 16: Settling thickening tank for solid–liquid separation of Septage at STP, Puri, Odisha

Source: CSE field visit, 2018

b) Geo-bags:

Geo-bags are long and narrow bags made from flexible, high strength and permeable material (Figure 17). They work on the principle of filtration. Once the FSS is pumped into the bag, the solids are retained in the bag while the liquid can be drained into the existing STP. The drawback of this method is that geo-bags once used cannot be reused and has to be disposed in an environmentally safe manner. The figure below shows geobags, placed on existing drying beds of an STP in Malaysia, for solid–liquid separation.

Figure 17: Use of geobags for solid–liquid separation of septage at STP in Melaka, Malaysia

Source: CSE field visit, 2018

c) Mechanical De-watering

• Belt Filter Press

The belt press involves a combination of gravity filtration and pressure applied between fabric belts to achieve solid–liquid separation. A polymer is added as a pre-conditioning upstream of the press to aid the de-watering. After passing through various zones of gravity filtration, low pressure and high pressure zones, the sludge is finally scraped off the belt for the next stage of treatment or disposal.

• Screw Press

FSS is passed through a screw or an auger contained within a perforated basket. The diameter of the screw increases along the length of the press while the gap between blades decreases. Thus, once the FSS enters the press, the pressure increases along the length of the press. The screw press also requires pre-conditioning by adding a polymer to aid the de-watering process. The de-watered cake drops out from the end of the press.

The solid content of the output sludge from mechanical de-watering option would be in the range of 15–25% and may or may not require further de-watering. The de-watered sludge would still contain pathogens. Further, treatment may be required based on the end use.

Figure 18: Use of screw press for solid–liquid separation of septage at Pentai STP in Malaysia

Source: CSE Site Visit, 2018

ii. FSS with solids content greater than 5%

a) Sludge drying beds

- Unplanted Drying Beds

These modules achieve solid–liquid separation through evaporation and filtration. The beds typically contain a watertight box that is open from the top. The box typically contains a layer of sand (300mm thick) and gravel (200–450mm thick) and an under drain at the bottom of the bed for the conveyance of the liquid for further treatment.

Wet FSS is added at the top of the bed (upto 200mm thick layer), from which part of the free water percolates through the sand and gravel bed to the under drainage system for further liquid treatment and part of the water gets evaporated.

The performance of the unplanted drying bed depends on the type of weather and is more suited for hot and dry weather. In favourable environment, this module can achieve up to 20% solids content within 7 to 10 days of drying and may go upto few weeks in unfavourable climates. De-watering time varies from 4–15 days in hot and dry weather to 15–30 in wet and temperate weather. After which the bed needs to be de-sludged.

- Planted Drying Beds

Planted drying beds are constructed similar to the unplanted drying beds but with an addition to Emergent Macrophytes plants which are rooted in the bed but emerge above the sludge surface. Water loss occurs through a combination of evaporation, evapo-transpiration and percolation. The sludge is cyclically loaded with resting periods for drying and cracking.

These beds differ from unplanted drying in the desludging period, which is much higher i.e. 1 to 3 years as compared to a few weeks in unplanted drying beds. The accumulated sludge is allowed to reach a depth of 1m to 1.5m before it is de-sludged. This is possible since the plant roots open up drainage path in the sludge and facilitates evaporation, evapo-transpiration and percolation. The challenge in planted drying beds is that both under loading and over loading can lead to the dying of the plants.

Figure 19: Planted drying beds used for solid–liquid separation at FSTP, Leh, India

(Source: MOUNT, CSE)

5.2 Comparison of various technologies for co-treatment

Several solid–liquid separation treatment technologies have been discussed in this chapter and based on the CAPEX, OPEX, land requirement, energy requirement, skill manpower requirement and reuse opportunity etc., either technology can be selected while planning for co-treatment of FSS in an STP.

A brief comparison of key parameters between various technologies mentioned above is shown below:

Table 12: Decision-making matrix for selecting co-treatment technology option

Parameters for comparison	Mechanized options	Non-mechanized options			Homogenization and controlled discharge
		Settling Thickening Tank	Planted / Unplanted Drying Beds	Geo-Bags	
Land Requirement	Lowest among all solid–liquid separation options	Lower than drying beds	Highest among all options	Significantly reduced as compared to drying beds.	Low since solid–liquid separation not proposed
Energy Requirement	Highest among all options	Pumping required for transporting the separated solids.	Can work entirely on gravity. Pumping may be required for filtrate.	Can work entirely on gravity. Pumping may be required for filtrate.	Can work entirely on gravity. Pumping may be required for filtrate.
CAPEX	High due to electromechanical equipment and civil infra needed	Low	High due to higher footprint	Low	Lowest
OPEX	High due to power cost, periodic maintenance and consumables	Low. Although pumping is still required	Low; periodic sludge removal needed	High; recurring expenditure related to replacement of Geo-bags	Lowest
Skilled labour Requirement	Skilled labour needed	Low	Low	Low	Low
Treatment efficiency	Highest. The separated solids has TS in the range 15-25%, may or may not require further drying.	Separated solids has TS in the range (5–10%) need further drying and liquid may contain significant solids as well.	High although significant resting period needed for drying.	Separated solids would need further drying.	Depends on the efficiency of the STP in question. Additional modules may be required in case treatment efficiency drops
Risk factor	Need to check the availability of spare parts, consumables, monitoring polymer dosing and need skilled manpower	Active sludge management required.	Safe handling of sludge needs to be ensured	Disposal / Reuse of geo-bags is an issue. Safe handling of sludge needs to be ensured.	Need to constantly monitor of FSS parameters and flow rate to avoid damage of infrastructure

Adapted from S. Singh et al., 2017

It is to be noted that the solid and the liquid component separated from the above technology may still require further treatment depending upon the end-use.

The separated solids would be high in pathogen content. Co-composting with organic solid waste is an effective technique to not only remove the pathogens but also improve the saleability of the end product.

The separated liquid may or may not have characteristics similar to sewage. They would, in particular, be high in nutrient contents since a major portion of the nutrient in FSS is in dissolved form. The impact on the effluent discharge parameters of the STP would require to be monitored. In case the effluent parameters do not meet, restrictions would have to be made on the discharge of FSS in the STP or additional modules would be required to treat it.

6. Recommendation for co-treatment in Lucknow

In order to implement co-treatment at the STP in Bharwara, the following information would be required:

1. Spare capacity at the Bharwara STP to treat FSS
2. Influent characteristics of FSS
3. Existing STP technology and possibility of process disruption and overloading due to the addition of FSS
4. An assessment on the impact of FSS on the STP performance. This should include impact of FSS on hydraulics, oxygen requirement, compliance with respect to discharge standards and adequacy of the existing sludge drying beds.

In order to avoid overloading and process disruption of the STP, worst case scenario is considered. The analysis is presented below:

6.1 Analysis for suitability of Bharwara STP to treat FSS

a) Calculation of Spare Capacity at Bharwara STP

The design capacity of the STP is 345 MLD. The design COD for sewage varies from 500 mg/l to 1000 mg/l. To account for the worst case scenario, lower value of design COD is considered for the analysis.

The calculation of Design Organic Load for the STP is calculated below:

	Parameter	Value	Units
(i)	STP capacity	345	MLD
(ii)	Design sewage COD	500	mg/L
(A) = (i) x (ii)	Design Organic Loading Rate	172500	Kg (COD)/day

In order to calculate the operational organic load in the STP, the operating capacity and influent COD observed in the STP is taken. The STP is presently operating under full capacity. The influent COD as per the test reports varies from 260 mg/l to 300 mg/l. For the purpose of analysis worst-case scenario of 300 mg/l has been taken.

The calculation of the Operational Organic Load for the STP is given below:

	Parameter	Value	Units
(iii)	STP (Operating cap)	345	MLD
(iv)	Influent COD	300	mg/L
(B) = (iii) x (iv)	Operational Organic Loading Rate	103,500	Kg (COD)/day

By subtracting the Operational Organic Load from the Design Organic Load we get the spare capacity of the STP to treat additional Organic Load due to the addition of the FSS. The spare capacity is shown below:

	Parameter	Value	Units
(C) =(A)-(B)	**Spare Capacity:**	**69,000**	**Kg (COD)/day**

b) Impact of variable FSS load on the spare capacity of Bharwara STP
Characteristics of FSS were found to be highly variable with COD varying from 6,000 mg/l to 1,20,000 mg/l. A scenario analysis has been done considering low strength, medium strength and high strength FSS and how it impacts the spare capacity of the STP to treat the organic load. The worst case scenario i.e. high strength is then considered for the design for co-treatment options.

Table 13: Impact of FSS variability on Co-treatment capacity of STP

S No	Influent FSS	COD (mg/l)	STP capacity to treat FSS (MLD)	STP capacity to treat FSS (% of STP design capacity)
1	Low strength	6,000	11.50	3.3
2	Medium strength	50,00	1.38	0.4
3	High strength	120,000	0.57	0.2

c) Deciding on the volume of FSS which can be added to an STP
Based on the analysis from the above section, where the spare capacity to treat organic load is compared at varying characteristics of FSS, the STP can treat between 0.5 MLD to 11.5 MLD (i.e. 0.2–3.3% of the capacity of the STP) of influent FSS.

In addition to the spare capacity with respect to the organic loading rate, the impact of FSS addition on other limiting factors like as pH, nutrient load, F/M ratio also needs to be analysed to ensure optimal treatment efficiency of the STP. Due to absence of such a study, the worst case scenario is considered and **it is recommended to restrict the overall FSS discharging to the STP to 0.5 MLD (or 0.2% of STP capacity) to start with. Depending upon the performance of the STP, the volume of FSS influent can be increased gradually**.

This recommended restriction of FSS addition is sufficient to treat the present demand of 30 KLD from de-sludging operators operating in the locality. Further, the addition of a solid–liquid separation module would mean that effectively only 15 KLD (approximately) of additional influent would reach the STP whose COD would be much lower than that of influent FSS discharged by the de-sludgers.

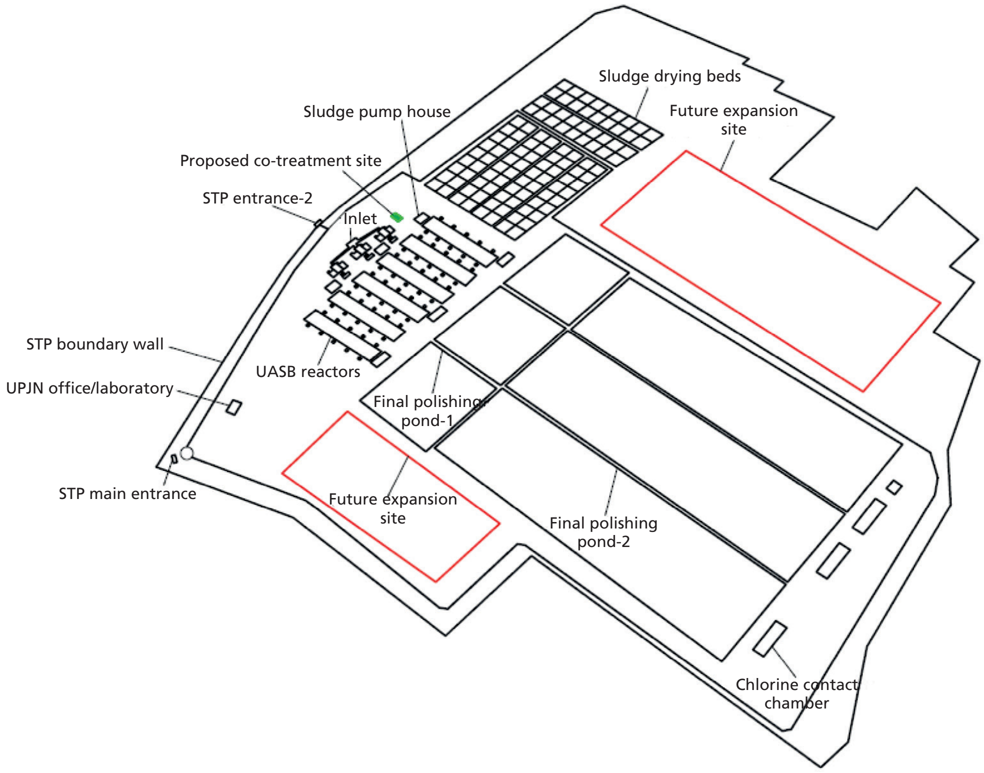
d) Monitoring requirement to avoiding overloading and processing disruption of the STP:
While it is feasible to co-treat the FSS in the STP, it is important to constantly monitor the performance of the STP in order to avoid overloading, process disruption and damage to the existing infrastructure. Some important points to be noted are provided below:

- The STP is based on anaerobic (UASB) technology that means it would be sensitive to variations in pH, nutrient and heavy metals load. Parameters such as F/M ratio needs to be regularly monitored. These parameters would need to be constantly monitored and in case the quality of effluent deteriorates, restrictions would be needed on the discharge of FSS.
- In future, as the sewerage network is expanding and more households are connected, the influent COD load of sewage would be expected to increase thereby reducing the spare capacity to treat. It is necessary to constantly monitor the influent sewage characteristics and subsequently design and plan for additional modules (like anaerobic or anoxic tanks) for the future. The additional modules would be required in case the influent sewage load increases or the effluent quality is severely impacted due to the addition of FSS.

6.2 Proposed treatment options at Bharwara STP

Based on the test results, different options are proposed for a capacity to handle 30 KLD of FSS (based on present demand). Based on site availability and accessibility, the location for the proposed co-treatment unit has been presented below.

Figure 20: Proposed site for co-treatment at Bharwara STP



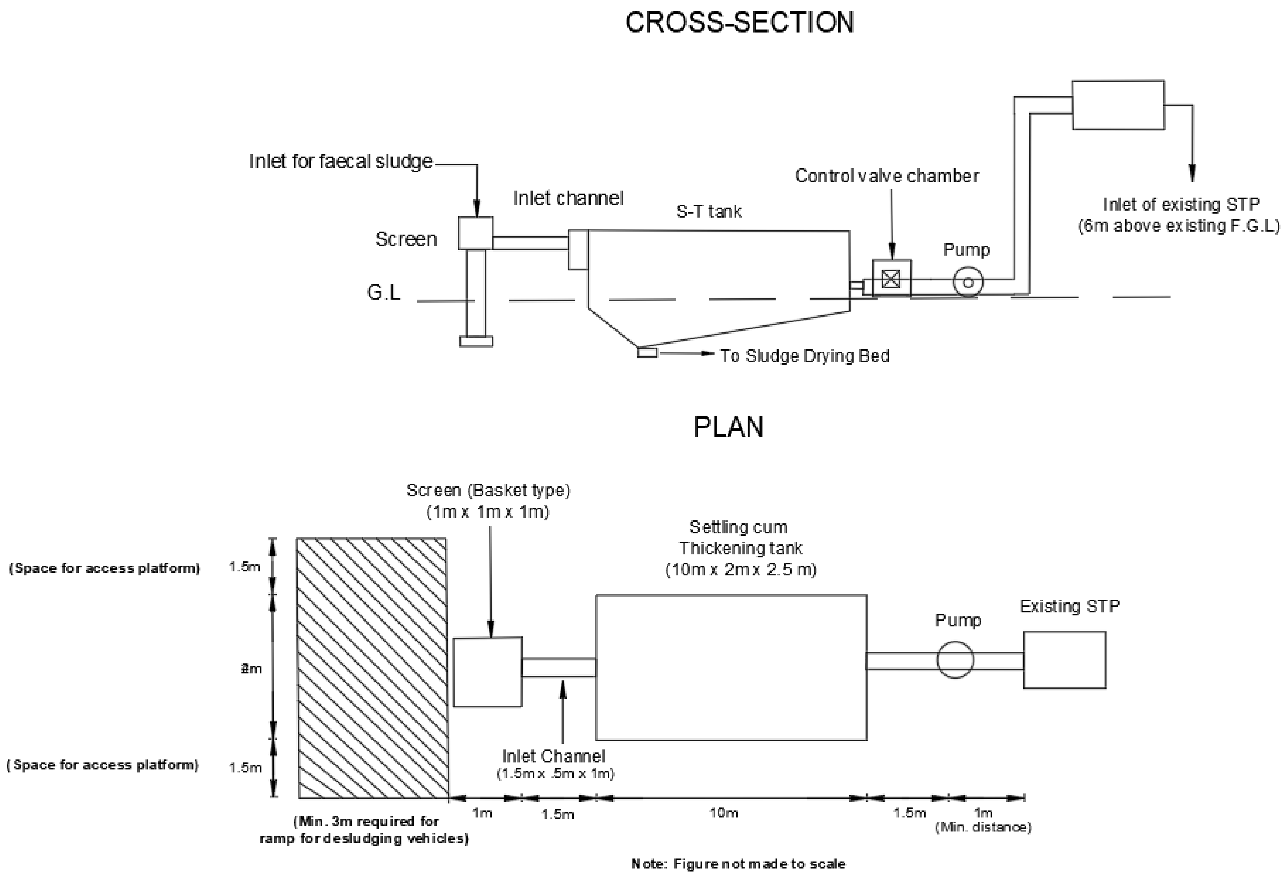
a) Option 1: Non mechanized solid–liquid separation (30 KLD)
Suitable for FSS with Total Solids > 01% and partially digested FSS (i.e. COD/ BOD_5 ratio greater than 2). In case fresh FSS is received, stabilization would be needed before this step to improve the settling of of the solids.

In case higher solids content and organic load is observed in the FSS, solid–liquid separation unit is proposed. The separated liquid would be treated in the existing STP while the separate solids would be treated separately either in the existing drying beds or separate facility. The proposed modules for this option include:

i. Screening and grit removal
ii. Settling / thickening tank
iii. Control valve chamber
iv. Pump house with sump

An indicative plan and section of the proposed modules is shown below:

Figure 21: **Plan and section for co-treatment–option 1**



Approximate area required for this option is 100–110 sqm.

Table 14: **Approximate break up of Capex for co-treatment–option 1**

S No	Description	Amount* (INR Lakhs)
1	Tanker receiving station (with ramp), screening, receiving chamber	1.5
2	Settling thickening tank	15
3	Pump-house with sump	2
4	Shed (open shed with concrete floor 4 m x 14m)	2
5	Electrification Contingency (~ 5%)	1.5 1
	Total	**23**

(based on CPWD rates 2018)

The option would need active sludge management and dedicated drying beds to further treat (de-water) the separated solids (not included in the cost). If there is no existing sludge storage room or sludge is not directly used in the drying beds, a sludge storage room will be required that will cost around 7–8 Lakh.

Approximate O&M cost for option 1 would be Rs 14,700 per month. This would include manpower, power cost for pumping, consumables and periodic repair and maintenance. Break-up shown below:

Table 15: Approximate break up for O&M cost for option 1

S No	Description	Amount* (INR per month)
1	Operator (1 workday of semi skilled staff @ Rs 300/day)	9,000
2	Power requirement for pumping 2 no. pumps (@ 8 hrs pumping 1 HP pump; Rs 5 per unit)	2,000
3	Periodic Repair & Maintenance (LS)	3,000
	Contingencies (~5%)	700
	Total	**14,700**

Guidance for operation and monitoring:
It is important that certain operating procedures that needs to be followed to ensure crude co-treatment does not affect the treatment performance at STP and sewerage infrastructure from pumping station to the STP, which are as follows:

- Release control: Based on the wastewater discharge flow from pumping house to the STP, the discharge of FSS to the influent sewage should be in the ratio 1% or less.
- Flow control meter at the pumping station should be installed to regularly monitor the flow.
- Influent and effluent parameters to be monitored regularly. Excessive deviation from the designed capacity might affect the treatment performance. If a definite pattern is observed, additional treatment modules would be required.
- The impact of FSS on the STP performance should be monitored. This should include impact of FSS on hydraulics, oxygen requirement, compliance with respect to discharge standards and adequacy of the existing sludge drying beds.
- Post project monitoring should include measurement of characteristics of FSS before it enters the homogenization tank, inlet of the STP and at outlet of the STP. It is also desirable to periodically check the treatment efficiency of the STP by taking samples from inlet and outlet of each modules.

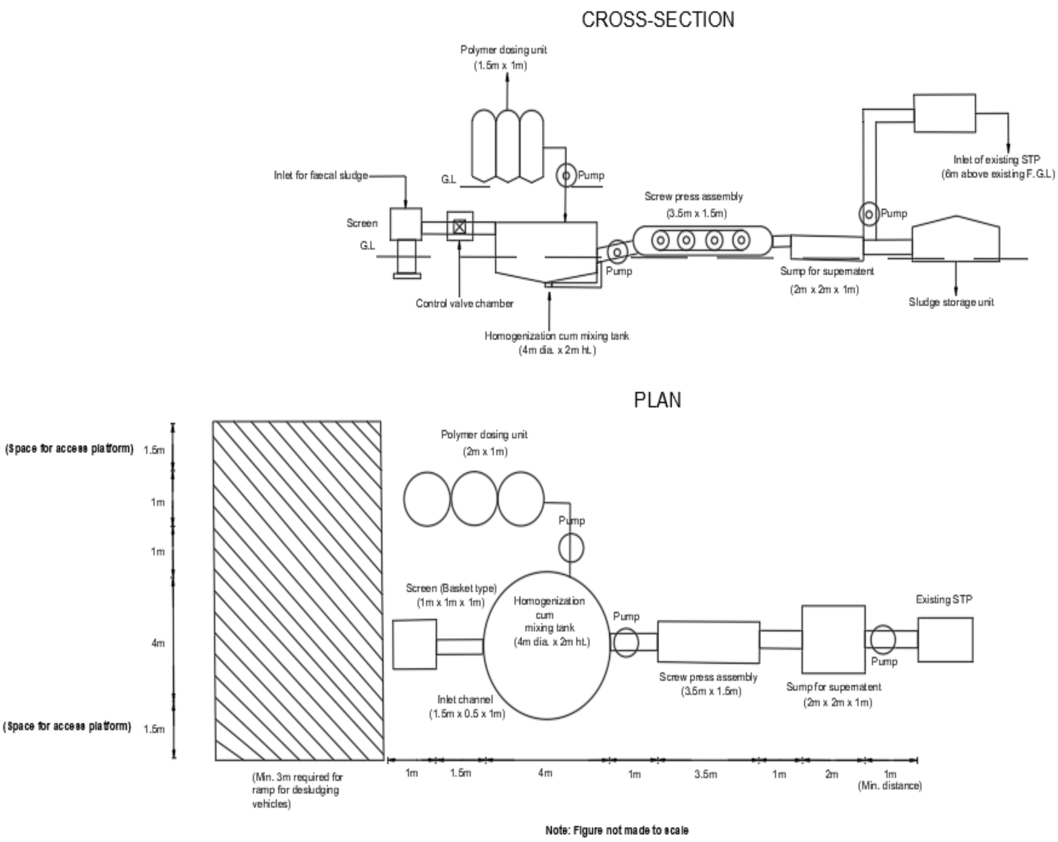
b) Option 2: Mechanized solid–liquid separation (30 KLD)
Suitable for FSS with total solids > 1%, availability of spare parts, skilled labour, consumables like polymers etc.

In case higher solids content and organic load is observed in the FSS, solid–liquid separation unit is proposed. The separated liquid would be treated in the existing STP while the separate solids would be treated separately either in the existing drying beds or separate facility. The separated solids from this option is in the range of 15–25%, which reduces the need to drying beds. However, the option would need the availability of spare parts, skilled labour and active monitoring of polymer dosing to ensure efficient operations. Further, the mechanical press manufacturer would be required to be involved from the planning and design stage itself to ensure the machine is designed to provide the required performance based on the expected FSS characteristics.

The proposed modules for this option include:
i. Screening and grit removal:
ii. Homogenization / holding tank:
iii. Valve chamber
iv. Polymer dosing unit
v. Screw press
vi. Pump house with sump

An indicative plan and section of the proposed modules is shown below:

Figure 22: Plan and section for co-treatment–option 2



Approximate area required for this option is 100–120 sqm. However, there would be considerable land saving with respect to sludge drying beds as the separated solids would have a solids contents of 20% and would need very less drying time as compared to the non-mechanized option.

Table 16: Break up of approximate Capex for co-treatment—Option 2

S No	Description	Amount (INR Lakhs)
1	Tanker receiving station (with ramp), screening, receiving chamber	1.5
2	Homogenization tank for FSS receiving and polymer dozing including civil works for conveyance	8
3	Screw press (approximate inclusive of ancillary infrastructure for polymer dozing)[1]	15
4	Pump-house with sump	2
5	Shed (open shed with concrete floor 7m x 14m)	2.5
6	Electrification	3
	Contingency (~ 5%)	1.5
	Total	**33.5**

(based on CPWD rates 2018)

If there is no existing sludge storage room or sludge is not directly used in the drying beds, a sludge storage room will be required that will cost around 7–8 lakhs.

Approximate O&M cost for option 2 would be Rs 32,500 per month. This would include manpower, power cost for pumping, consumables and periodic repair and maintenance. Break-up shown below:

Table 17: Approximate break-up for O&M Cost for co-treatment–Option 2

S No	Description	Amount (INR per month)
1	Operator (1 workday of skilled staff @ Rs 600/day)	18,000
2	Power requirement for pumping 3 no. pumps (@ 8 hrs pumping 1 HP pump; Rs 5 per unit)	3,000
3	Power requirement for screw press (2 HP; 8 hr operation)	2,000
4	Consumables	5,000
5	Periodic Repair & Maintenance (LS)	3,000
	Contingencies (~5%)	1,500
	Total	**32,500**

Guidance for operation and monitoring:
It is important that certain operating procedures that need to be followed to ensure crude co-treatment do not affect the treatment performance at an STP and sewerage infrastructure from pumping station to the STP, which are as follows:

- Release control: The discharge of FSS to the influent sewage should be restricted initially to 0.2%. The ratio can be increased depending upon STP performance while monitoring the FSS and influent sewage chracteristics.
- Flow control meter at the pumping station should be installed to regularly monitor the flow.
- Influent and effluent parameters to be monitoring regularly. Excessive deviation from the designed capacity might affect the treatment performance. If a definite pattern is observed, additional treatment modules would be required.
- The impact of FSS on the STP performance should be monitored. This should include impact of FSS on hydraulics, oxygen requirement, compliance with respect to discharge standards and adequacy of the existing sludge drying beds.
- Post-project monitoring should include measurement of parameters of the faecal sludge before it enters the homogenization tank, inlet of the STP and at outlet of the STP. It is also desirable to periodically check the treatment efficiency of the STP by taking samples from inlet and outlet of each modules.

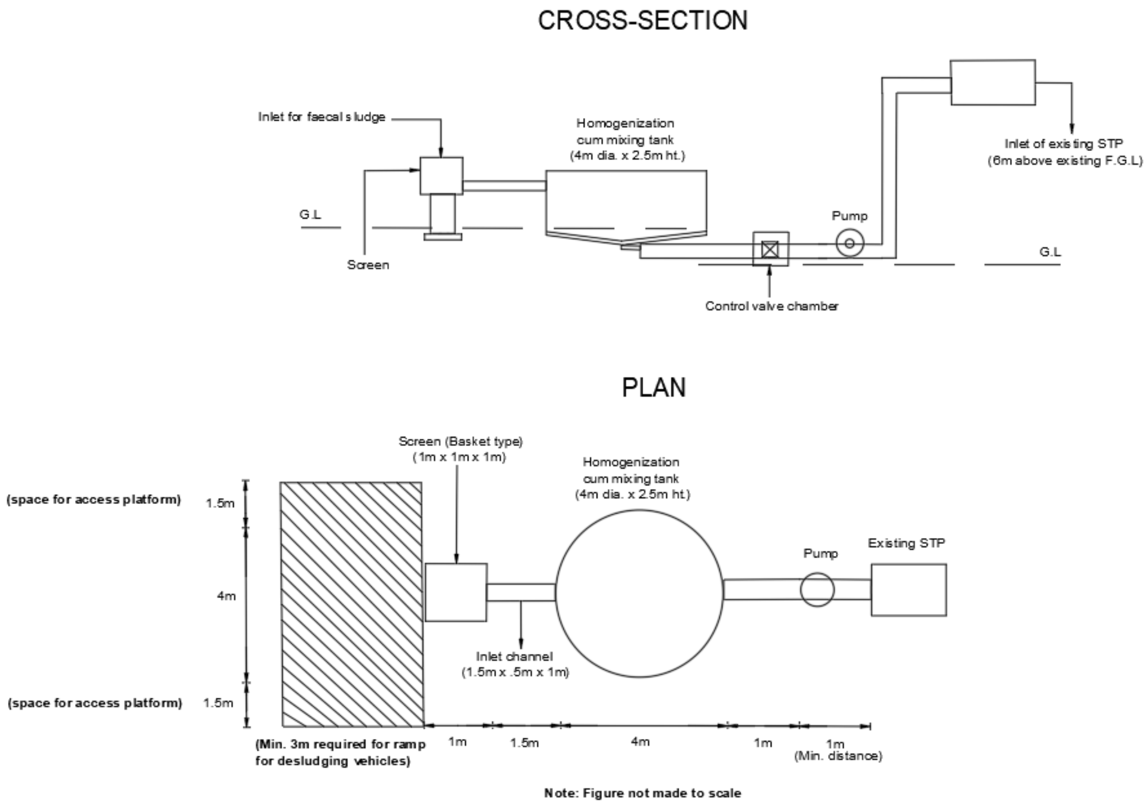
c) Option 3: Homogenization and controlled discharge at STP (30 KLD)
This option is suitable where the total solids of influent FSS is less than 1% and STP has the capacity to treat additional organic and nutrient load.

A homogenization tank of 30 KL capacity with a valve or pump is proposed for a controlled discharge to the STP. In this method no solid–liquid separation is undertaken, the FSS is mixed with the influent with a pre-defined ratio. As evaluated in the earlier chapter, the ratio of FSS addition can initially be restricted to 0.2% and increased gradually while monitoring the treatment efficiency of the plant. This method loses out on the benefit of bio-solids rich in nutrient generated by solids separated from FSS. The module for this option includes (Figure 23)

i. Screening
ii. Homogenization cum mixing tank

iii. Valve chamber
iv. Pump for conveyance to the existing STP

Figure 23: Plan and section for co-treatment–Option 3



Approximate area required for this option is approximately 60–70 sqm.

Indicative cost for Option 3 is Rs 18.50 lakhs. The break-up of the same is provided below:

Table 18: Approximate break-up of Capex for co-treatment option 3

S No	Description	Amount (Rs Lakhs)
1	Tanker receiving station (with ramp), screening, receiving chamber	1.50
2	Homogenization cum mixing tank (civil)	8.00
3	Mechanical works for mixing in the homogenization tank	5.00
4	Valve with chamber and pump for lifting to existing STP inlet (6m above existing Level)	2.00
5	Electrification	1.50
	Contingency (~5%)	0.50
	Total	**18.50**

(based on CPWD rates 2018)

Approximate O&M cost for the option would be Rs 10,000 per month. This would include manpower for monitoring and power cost for pumping and periodic repair and maintenance. Break-up is shown below:

Table 19: Approximate break-up of O&M cost for Option 3

S No	Description	Amount (INR per month)
1	Operator (1/2 workday of unskilled staff @ Rs 300/day)	4,500
2	Power requirement for pumping (@ 8 hrs pumping 1 HP pump; Rs 5 per unit)	1,000
3	Power requirement for mixer (3 HP)	3,000
4	Periodic Repair & Maintenance (LS)	1,000
	Contingencies (~5%)	425
	Total	**9925 or 10,000 (approx.)**

Guidance for operation and monitoring:
It is important that certain operating procedures that needs to be followed to ensure crude co-treatment does not affect the treatment performance at STP and sewerage infrastructure from pumping station to the STP, which are as follows:

- Release control: Based on the wastewater discharge flow from pumping house to the STP, the discharge of FSS to the influent sewage should initially be restricted to 0.2% or less and gradually increased depending upon the treatment efficiency of the plant.
- Flow control meter at the pumping station should be installed to regularly monitor the flow.
- Influent and effluent parameters to be monitored regularly. Excessive deviation from the designed capacity might affect the treatment performance. If a definite pattern is observed, additional treatment modules would be required.
- The impact of FSS on the STP performance should be monitored. This should include impact of FSS on hydraulics, oxygen requirement, compliance with respect to discharge standards and adequacy of the existing sludge drying beds.
- Post project monitoring should include measurement of parameters of the FSS before it enters the homogenization tank, inlet of the STP and outlet of the STP.

d) Option 4: Discharge at Sewage Pumping Stations (SPS)
This option is suitable where the total solids of influent FSS is less than 1% and STP has the capacity to treat additional organic and nutrient load from FSS.

Depending upon the availability of land, capacity of the pumps installed, the minimum flow at the Sewage Pumping Stations (SPS) and strength on the influent FSS, the FSS may be discharged at the SPS (preferably Main Pumping Station).

An arrangement similar to Option-3 (i.e. controlled flow from the homogenization tank) can be proposed at the SPS site itself. The effluent from the homogenization tank can be discharged in the existing sump of a SPS. The main pumping station located at Gwari is one such potential site. The pumping station receives the waste water from *nullahs* as well as sewerage network and pumps it to the Bharwara STP.

Guidance for operation and monitoring:
The following operating procedures are needed to ensure co-treatment does not affect the treatment performance at STP and sewerage infrastructure:

- Flow control meter at the pumping station should be installed to regularly monitor the flow towards the STP from the pumping station.

- The pump at the pumping station should be at the lowest level of reservoir to ensure all the settled solids are pumped and not accumulated at the bottom of the reservoir at the pumping station. This will reduce the storage capacity of the reservoir if the solids are settled at the bottom.
- In order to avoid settling and accumulation of solids at the bottom the sump, FSS should only be released if there is a minimum level of water in the sump. This level can be the top most point of the inlet of the pump.
- Sludge should not be released in case the water level in the reservoir is above the maximum level as shown below to avoid over spilling.
- In case FSS is being discharged at multiple SPS locations, monitoring and recordkeeping of the FSS discharge operation should be done. Preferably, CCTVs should be there for effective management and control.
- Post-project monitoring should include measurement of characteristics of the FSS before it enters the homogenization tank and after it has been diluted with sewage at inlet of SPS.

Figure 24: Sump of the main pumping station at Gwari, Lucknow

Source: CSE field Visit December 2018

e) Option 5: Discharge at the sludge drying beds of existing STP

Suitable for FSS with TS greater than 5% and volume low enough such that the sludge management of the existing STP is not affected.

Preliminary screening is recommended before discharging at the drying beds. FSS should be left on the bed for up to 7 to 10 days depending upon the weather. FSS is dried through percolation and evaporation. After which it needs to be removed for further treatment, reuse or disposal at a landfill as appropriate. A roof with transparent sheet covering can also be proposed at such location to make the facility operational in all seasons.

The adequacy of the existing drying beds to treat the STP sludge as well as the FSS needs to be determined. Geo-bags can be used in order to minimize the requirement of existing drying beds for Co-Treatment. In case the number of existing drying beds are not adequate for Co-Treatment of FSS, additional drying beds can be constructed subject to land availability.

(Footnotes)

1 Attached in the Annexure 2, the cost of the screw press (2 quotations) and belt filter press and design layout by one of the vendors for reference. One of the vendor has quoted an exceedingly high cost (~30 lakhs) as compared to other vendors and hence not considered for the estimate. On comparison among three we can see that the cost of only de-watering unit will be in the range of Rs 8–12 lakh for a flow rate of 4–5 m3/hr with Influent TSS around~15000 mg/l. There would be additional cost associated with ancillary equipment and modules (polymer dozing, conveyance mechanism for separated liquid and solids) needed for the use of screw press which is in the range of Rs 5–7 lakhs.

7. Way forward for implementation

7.1 Suggestions in tendering

The tendering process of co-treatment needs to ensure that there are incentives for the bidders to implement a cost-effective and robust technology for treatment of FSS. The following points need to be ensured in the tendering procedure for co-treatment in case a design agnostic approach is followed:

1. Basic details of all the STPs, where co-treatment is proposed, need to be provided. This should include the treatment process, design capacity, STP layout plan, test reports to ascertain in influent and effluent parameters of the STP and land availability for co-treatment modules.

2. The range of characteristics of the influent FSS expected needs to be mentioned in the tender. The tender also needs to stress that the proposed module should take into account the high variability of the characteristics of FSS.

3. The proposed outlet characteristics of the effluent from the co-treatment module (or influent to the STP) needs to be mentioned in the tender. Since the purpose of the co-treatment module is primarily for solid–liquid separation, the outlet parameters should be defined in terms of solid contents or percentage change of the total solids. This can be:
    a. The separated solids (after the drying) should have solids content of at least 20%.
    b. For the separate liquid, there should be a minimum solids reduction of 60%.

4. Instead of a percentage rate, it would be better to take separate quotes for capital cost and O&M cost and use the summation of capital cost and O&M cost for 5 years after adjusting for inflation for comparison to arrive at the least cost. This would encourage bidders to quote a cost-effective technology.

Alternative Approach:

a. Individual tender based on a predefined technology can be floated initially for one STP in a pilot approach. The learnings from this intervention can be applied for scaling-up the interventions across STPs in the state.

b. The technology can be defined based on Chapter-6 discussion. A solid-liquid separation module i.e. option 6.1 and 6.2 is desirable for FSS with high solids content.

c. Details on the STP as mentioned above must be provided to the bidder.

d. In this scenario, the existing tendering option of percentage rate contract would be ideal since UP Jal Nigam can easily estimate the capital and O&M cost since the technology is defined.

7.2 Re-use of by-products from FSS treatment

Reuse and revenue generation potential of the sludge generated from the co-treatment should also be taken into consideration. The manure generated from FSS is very high in nutrient content and has good potential for use in agriculture. The projects should also explore the possibility of co-composting of sludge generated from FSS treatment with organic municipal solid waste, which further helps to improve the nutritional value of compost and reduce the pathogen content. In order to ensure there is a good market for manure generated from co-treatment, there is a need to sensitize the end users about the benefits of organic compost and incentives are needed from the authority to promote its use. There are examples from Bangladesh (for example, Sakhipur Plant) where the treated sludge from FSTP is co-composted with organic municipal solid waste. The manure here has gathered popularity among local farmers.

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Annexure 1: Details of Bharwara STP and co-treatment initiative in Lucknow

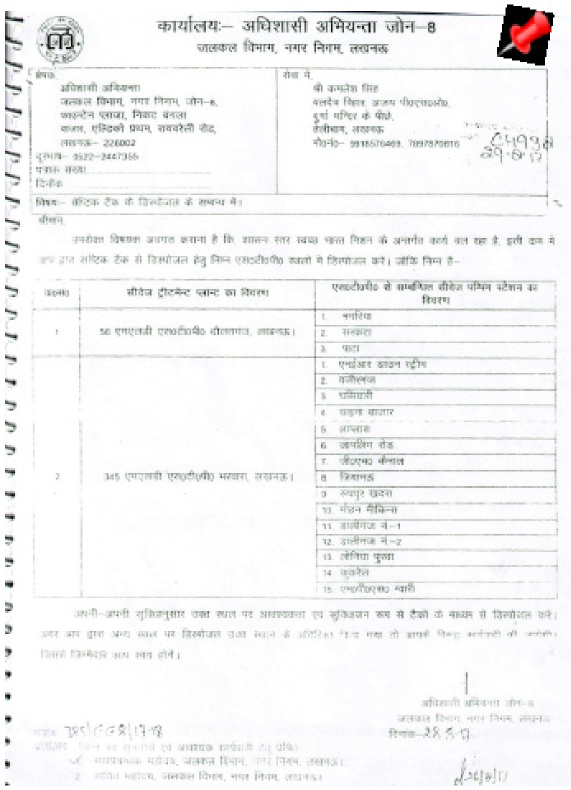
1.1 Details of Bharwara STP

Name/ Location of STP	345 MLD STP Bharwara, Lucknow
Year of commissioning	2011
Process of Sewage Treatment	UASB based technology.
Designed Capacity/day	345 MLD
Treatment units	No.
Inlet chamber to STP	01 : 20mx9mx4m SWD
No. of stream exit	03 : 115 MLD capacity each
Distribution chamber	03
Screen (mechanical)	02 : For each stream (6mx1.8mx1m)
Grit chamber (mechanical)	06 , 02 working for each stream 03 , 01 for each stream (10mx1.5mx1.5m)
Parshall Flume	03 , (8mx2.5mx2.25m)
Division Box	30 Nos (32mx28mx4.6m)
Nos of UASB reactors	115 Total
Feed pipes (75 mm dia) HDPE	6,720,224 pipes/rector (904sqm.per pipe)
HRT at average flow	8.6 hrs
HRT at peak flow	5.6 hrs
Solid retention time (SRT)	35 days
Pre aeration tank	03
Surface aerators in pre aeration tank	06 ,02 of 30 HP in each stream (fixed type)
Polishing pond compartment	03 ,01 for each stream 140m x 140m x 3m SDW
Floating aerator for compartment no.1	18 , 06 surface aerator of 50 HP for each stream
Polishing pond compartment no 2	03 : 550mx140mx1.5m SDW
Chlorine contact tank	03 : 60mx20mx2m SDW
Chlorination	03 : 50 kg/hr ,Booster pump 20 m^3/hr@6kg/cm^2
Sludge concentration	65 kg/m^3
Total sludge generation (wet)	1812 m3/day
Total sludge generation (dry)	100 tons/day
Sludge sump	03 : 01 for each stream 9.85mx6.80mx1.0m
Sludge pump	18 68 m^3/hr at 35m
Sludge drying beds	106 :27mx27m
Sludge cycle	10 days
Filtrate water sump	02 :10mx7.5mx1.0m
Filtrate water pump	04 : 40m3/hr, 18m head
Total power requirement of STP	1500 KVA
Effluent pipe	1500m ,2400 mm dia RCC pipe
Dual fuel engine for bio gas utilization	02,850 KVA each
Gas flaring system	02 , Aspiration type pre mixing burner 6 above GL

UASB reactor details			
	Component A	**Component B**	**Component C**
No. of reactors per component	10 (5x5)	10 (5x5)	10(5x5)
Flow capacity	11.5x10(115)	11.5x10(115)	11.5x10(115)
Volume	300	300	300
Length	32	32	32
Width	28	28	28
Water depth	4.6	4.6	4.6
Distribution box	2	2	2
HRT (hrs) peak and average flow	5.6 & 8.5	5.6 & 8.5	5.6 & 8.5
Depth of sludge blanket	2	2	2
Upward velocity	0.75	0.75	0.75
No. of Inlet Pipes	224	224	224

Point of treated sewage disposal (river/ lake/ irrigation/ land and disposal / pisciculture/ aquaculture/any other)	River Gomti
Details of bypass arrangement at STPs, if any	Yes, 72.00 MLD is being discharge directly in river Gomti. (Projected Figure)
Method of sludge disposal	Land Application
Agency for operation and maintenance of STP	Ganga Pollution Control Unit, U.P. Jal Nigam, Lucknow
Power requirement for plant STP compound	1500 KVA
Status of power availability for uninterrupted and continuous running of STP and standby Arrangement for power. If any.	DG sets provided.
Status of Skilled/Trained Manpower	Skilled/trained manpower has been deployed for the better operation & maintenance of 345 MLD STP, Bharwara.
Availability of spare parts	As per requirement.
Difficulties in transfer of assets from implementing agency to O&M agency, if any.	None, whereas as implementing to O&M agency, if any.
Institutional mechanism for O&M	Staff of UP Jal Nigam.
Training provided to O&M	Yes, Training programmers organize time to time to for O& M staff.
Manpower available/as per norms-(Mechanical, Electrical, Public Health, Chemical, Unskilled	Manpower available as per norms.
Annual expenditure on O&M & STP (Salary, power, chemical etc.) for the last three years	105.0 Lacs
Amount of water cess a paid, if any	Not Applicable.
Volume of industrial waste being discharged in to STPs, if any	NA
Feasibility of private participation	Contractor carries out plant O&M.

1.2 Notification is issued by Lucknow Nagar Nigam



कार्यालयः— अधिशासी अभियन्ता जोन—8
जलकल विभाग, नगर निगम, लखनऊ

प्रेषक,
अधिशासी अभियन्ता
जलकल विभाग, नगर निगम, जोन—8,
लखनऊ— 226002
दूरभाष— 0522—2447366
पत्रांक संख्या.....
दिनांक

सेवा में,
श्री कमलेश सिंह
लखनऊ
मो०नं०— 9918570469, 7897870816

विषय— सेप्टिक टैंक के डिस्पोजल के सम्बन्ध में।

महोदय,

उपरोक्त विषयक अवगत कराना है कि शासन स्तर स्वच्छ भारत मिशन के अन्तर्गत कार्य चल रहा है, इसी क्रम में आप द्वारा सेप्टिक टैंक से डिस्पोजल हेतु निम्न एस०टी०पी० स्थलों में डिस्पोजल करें। जोकि निम्न है—

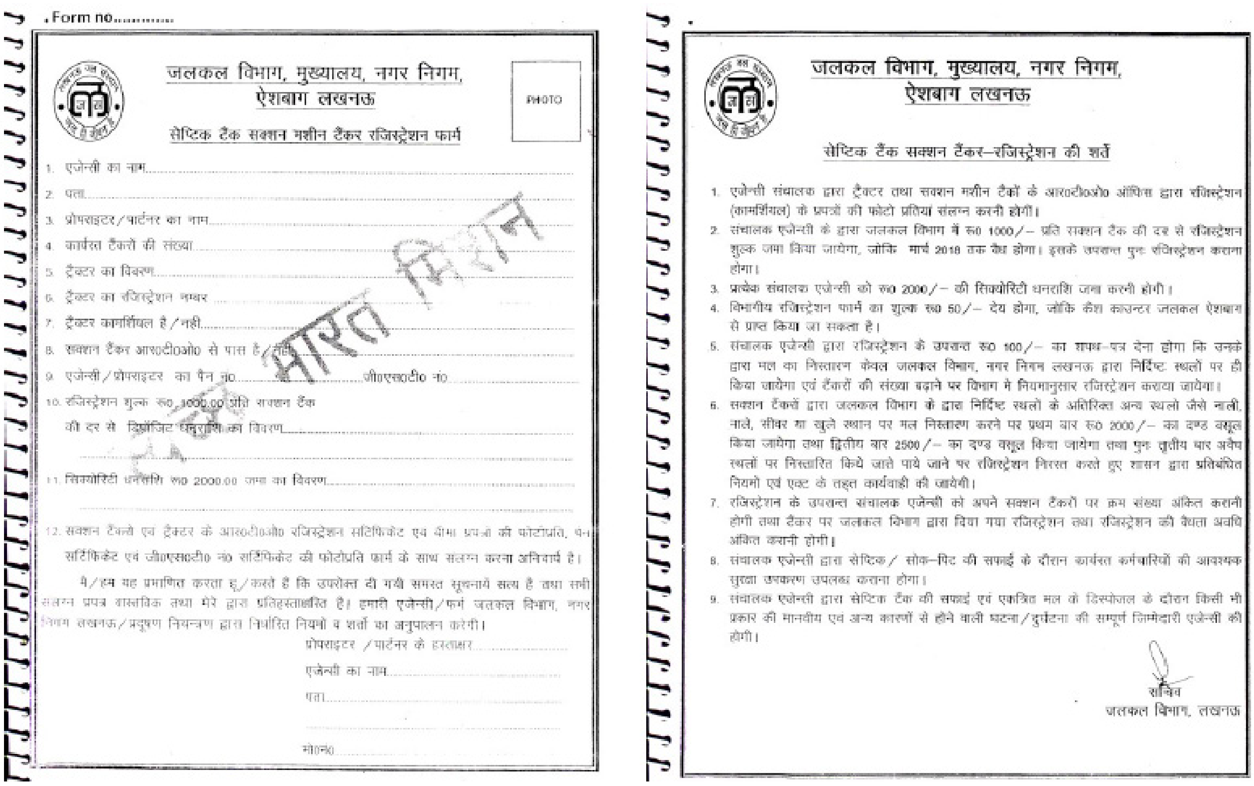
क्र०सं०	सीवेज ट्रीटमेन्ट प्लान्ट का विवरण	एस०टी०पी० से सम्बन्धित सीवेज पम्पिंग स्टेशन का विवरण
1	56 एम०एल०डी० एस०टी०पी० दौलतगंज, लखनऊ।	1. [illegible] 2. [illegible] 3. [illegible]
2	345 एम०एल०डी० एस०टी०पी० भरवारा, लखनऊ।	1. एन०ई०आर० डाउन स्ट्रीम 2. वजीरगंज 3. घसियारी 4. [illegible] बाजार 5. [illegible] 6. जापलिंग रोड 7. जी०एच० कैनाल 8. [illegible] 9. [illegible] 10. [illegible] 11. डालीगंज नं—1 12. डालीगंज नं—2 13. [illegible] 14. कुकरैल 15. [illegible]

अपनी—अपनी सुविधानुसार उक्त स्थल पर आवश्यकता एवं सुविधाजनक रूप से टैंकों के माध्यम से डिस्पोजल करें। अगर आप द्वारा अन्य स्थल पर डिस्पोजल उक्त स्थान के अतिरिक्त किया गया तो आपके विरुद्ध कार्यवाही की जायेगी। जिसके जिम्मेदार आप स्वयं होंगे।

अधिशासी अभियन्ता जोन—8
जलकल विभाग, नगर निगम, लखनऊ
दिनांक—28.5.17

प्रतिलिपि— निम्न को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित।
1. महाप्रबन्धक महोदय, जलकल विभाग, नगर निगम, लखनऊ।
2. सचिव महोदय, जलकल विभाग, नगर निगम, लखनऊ।

Figure 26: Notice for decanting at designated sites



Form no............

जलकल विभाग, मुख्यालय, नगर निगम,
ऐशबाग लखनऊ

PHOTO

सेप्टिक टैंक सक्शन मशीन टैंकर रजिस्ट्रेशन फार्म

1. एजेन्सी का नाम.........
2. पता.........
3. प्रोपराइटर/पार्टनर का नाम.........
4. कार्यरत टैंकरों की संख्या.........
5. ट्रैक्टर का विवरण.........
6. ट्रैक्टर का रजिस्ट्रेशन नम्बर.........
7. ट्रैक्टर कामर्शियल है/नही.........
8. सक्शन टैंकर आर०टी०ओ० से पास है/नहीं.........
9. एजेन्सी/प्रोपराइटर का पैन नं०.........जी०एस०टी० नं०.........
10. रजिस्ट्रेशन शुल्क रू० 1000.00 प्रति सक्शन टैंक की दर से डिपॉजिट धनराशि का विवरण.........
11. सिक्योरिटी धनराशि रू० 2000.00 जमा का विवरण.........
12. सक्शन टैंकरों एवं ट्रैक्टर के आर०टी०ओ० रजिस्ट्रेशन सर्टिफिकेट एवं बीमा प्रपत्रों की फोटोप्रति, पैन सर्टिफिकेट एवं जी०एस०टी० नं० सर्टिफिकेट की फोटोप्रति फार्म के साथ संलग्न करना अनिवार्य है।

मै/हम यह प्रमाणित करता हू/करते है कि उपरोक्त दी गयी समस्त सूचनायें सत्य है तथा सभी संलग्न प्रपत्र वास्तविक तथा मेरे द्वारा प्रतिहस्ताक्षरित है। हमारी एजेन्सी/फर्म जलकल विभाग, नगर निगम लखनऊ/प्रदूषण नियन्त्रण द्वारा निर्धारित नियमों व शर्तो का अनुपालन करेगी।

प्रोपराइटर /पार्टनर के हस्ताक्षर.........
एजेन्सी का नाम.........
पता.........
मो०नं०.........

जलकल विभाग, मुख्यालय, नगर निगम,
ऐशबाग लखनऊ

सेप्टिक टैंक सक्शन टैंकर—रजिस्ट्रेशन की शर्तें

1. एजेन्सी संचालक द्वारा ट्रैक्टर तथा सक्शन मशीन टैंकों के आर०टी०ओ० ऑफिस द्वारा रजिस्ट्रेशन (कामर्शियल) के प्रपत्रों की फोटो प्रतियां संलग्न करनी होगी।
2. संचालक एजेन्सी के द्वारा जलकल विभाग में रू० 1000/— प्रति सक्शन टैंक की दर से रजिस्ट्रेशन शुल्क जमा किया जायेगा, जोकि मार्च 2018 तक वैध होगा। इसके उपरान्त पुनः रजिस्ट्रेशन कराना होगा।
3. प्रत्येक संचालक एजेन्सी को रू० 2000/— की सिक्योरिटी धनराशि जमा करनी होगी।
4. विभागीय रजिस्ट्रेशन फार्म का शुल्क रू० 50/— देय होगा, जोकि कैश काउन्टर जलकल ऐशबाग से प्राप्त किया जा सकता है।
5. संचालक एजेन्सी द्वारा रजिस्ट्रेशन के उपरान्त रू० 100/— का शपथ—पत्र देना होगा कि उनके द्वारा मल का निस्तारण केवल जलकल विभाग, नगर निगम लखनऊ द्वारा निर्दिष्ट स्थलों पर ही किया जायेगा एवं टैंकरों की संख्या बढ़ाने पर विभाग मे नियमानुसार रजिस्ट्रेशन कराया जायेगा।
6. सक्शन टैंकरों द्वारा जलकल विभाग के द्वारा निर्दिष्ट स्थलो के अतिरिक्त अन्य स्थलो जैसे नाली, नाले, सीवर या खुले स्थान पर मल निस्तारण करने पर प्रथम बार रू० 2000/— का दण्ड वसूल किया जायेगा तथा द्वितीय बार 2500/— का दण्ड वसूल किया जायेगा तथा पुनः तृतीय बार अवैध स्थलों पर निस्तारित किये जाते पाये जाने पर रजिस्ट्रेशन निरस्त करते हुए शासन द्वारा प्रतिबंधित नियमो एवं एक्ट के तहत कार्यवाही की जायेगी।
7. रजिस्ट्रेशन के उपरान्त संचालक एजेन्सी को अपने सक्शन टैंकरों पर क्रम संख्या अंकित करानी होगी तथा टैंकर पर जलकल विभाग द्वारा दिया गया रजिस्ट्रेशन तथा रजिस्ट्रेशन की वैधता अवधि अंकित करानी होगी।
8. संचालक एजेन्सी द्वारा सेप्टिक/ सोक—पिट की सफाई के दौरान कार्यरत कर्मचारियों को आवश्यक सुरक्षा उपकरण उपलब्ध कराना होगा।
9. संचालक एजेन्सी द्वारा सेप्टिक टैंक की सफाई एवं एकत्रित मल के डिस्पोजल के दौरान किसी भी प्रकार की मानवीय एवं अन्य कारणों से होने वाली घटना/दुर्घटना की सम्पूर्ण जिम्मेदारी एजेन्सी की होगी।

सचिव
जलकल विभाग, लखनऊ

Figure 27: Registration form and laid terms & conditions

1.3 Water Quality Test Results at Bharwara STP

लखनऊ नगर के गोमती काये योजना द्वितीय चरण के अन्तगंत सीवेज शोधन संयंत्रों की दैनिक परफामेन्स की मासिक सूचना

माह अक्टूबर, 2017 की प्रगति सूचना

प्रपत्र-4(ii)

नगर का नाम : लखनऊ

सीवेज ट्रीटमेन्ट प्लान्ट का नाम व टेक्नालाजी : भरवारा एस0टी0पी0, यूएएसबी टेक्नालाजी

सीवेज ट्रीटमेन्ट प्लान्ट की क्षमता : 345 एम.एल.डी.

एफ्लूएण्ट का निस्तारण : गोमती नदी

क्र. सं.	दिनांक	एस.टी.पी. पर प्राप्त सीवेज की मात्रा (एम.एल.डी.)	इनफ्लूएन्ट				एफ्लूएन्ट					प्रतिदिन पावरकट (मिनट)	प्रतिदिन DG सेट चलाया गया (मिनट)	टिप्पणी
			टी.एस.एस. (मि.ग्रा./ली.)	बी.ओ.डी. (मि.ग्रा./ली.)	सी.ओ.डी. (मिग्रा/ली.)	पी.एच.	टी.एस.एस. (मि.ग्रा./ली.)	बी.ओ.डी. (मि.ग्रा./ली.)	सी.ओ.डी. (मि.ग्रा./ली.)	डी.ओ. (मि.ग्रा./ली.)	पी.एच.			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	26.09.2017	294.00	245.00	138.00	248.00	7.29	34.00	27.00	60.00	4.90	7.62	-	-	
2	27.09.2017	281.00	254.00	145.00	256.00	7.25	37.00	26.00	72.00	5.00	7.60	-	-	
3	28.09.2017	283.00	236.00	140.00	240.00	7.22	39.00	28.00	68.00	5.10	7.67	8.00	5.00	
4	29.09.2017	283.00	222.00	148.00	232.00	7.31	35.00	26.00	80.00	4.90	7.63	-	-	
5	30.09.2017	278.00	228.00	150.00	224.00	7.26	39.00	25.00	64.00	5.00	7.68	-	-	
6	01.10.2017	309.00	237.00	140.00	240.00	7.32	37.00	27.00	72.00	5.10	7.65	-	-	
7	02.10.2017	296.00	201.00	148.00	220.00	7.22	33.00	25.00	60.00	5.00	7.56	-	-	
8	03.10.2017	331.00	226.00	145.00	232.00	7.28	36.00	26.00	68.00	4.90	7.65	-	-	
9	04.10.2017	299.00	232.00	150.00	240.00	7.23	38.00	28.00	80.00	5.10	7.52	-	-	
10	05.10.2017	331.00	226.00	140.00	228.00	7.30	35.00	25.00	72.00	5.20	7.69	-	-	Permissible
11	06.10.2017	346.00	240.00	148.00	232.00	7.27	38.00	27.00	80.00	5.10	7.66	15.00	10.00	limit of Effluent
12	07.10.2017	347.00	223.00	143.00	228.00	7.29	34.00	26.00	64.00	5.00	7.67	-	-	D.O.>4.0 mg/l
13	08.10.2017	346.00	221.00	140.00	224.00	7.25	35.00	28.00	56.00	4.90	7.64	-	-	BOD<30 mg/l
14	09.10.2017	345.00	231.00	143.00	236.00	7.22	39.00	25.00	68.00	5.00	7.63	-	-	COD<100 mg/l
15	10.10.2017	353.00	246.00	148.00	240.00	7.26	35.00	25.00	72.00	5.10	7.59	-	-	TSS<50 mg/l
16	11.10.2017	357.00	229.00	145.00	244.00	7.23	39.00	27.00	80.00	4.90	7.61	30.00	25.00	p^H = 7-8
17	12.10.2017	363.00	226.00	140.00	240.00	7.27	36.00	26.00	64.00	4.80	7.66	3.00	-	
18	13.10.2017	366.00	236.00	143.00	248.00	7.23	38.00	28.00	72.00	4.90	7.58	-	-	
19	14.10.2017	382.00	242.00	150.00	252.00	7.26	40.00	27.00	56.00	4.80	7.56	-	-	
20	15.10.2017	369.00	229.00	140.00	248.00	7.28	37.00	25.00	64.00	4.90	7.61	-	-	
21	16.10.2017	376.00	226.00	135.00	236.00	7.25	39.00	26.00	72.00	5.00	7.59	-	-	
22	17.10.2017	369.00	220.00	143.00	232.00	7.35	36.00	28.00	60.00	5.10	7.61	-	-	
23	18.10.2017	370.00	238.00	128.00	240.00	7.30	33.00	26.00	64.00	5.20	7.56	-	-	
24	19.10.2017	370.00	223.00	133.00	228.00	7.28	38.00	24.00	72.00	5.10	7.55	-	-	
25	20.10.2017	356.00	246.00	135.00	236.00	7.31	39.00	26.00	80.00	4.90	7.58	-	-	
26	21.10.2017	353.00	238.00	125.00	248.00	7.33	36.00	28.00	68.00	5.00	7.55	-	-	
27	22.10.2017	364.00	226.00	123.00	224.00	7.35	38.00	25.00	76.00	4.90	7.56	-	-	
28	23.10.2017	329.00	221.00	123.00	220.00	7.45	37.00	27.00	80.00	4.80	7.65	-	-	
29	24.10.2017	343.00	225.00	128.00	232.00	7.29	36.00	26.00	72.00	5.00	7.62	-	-	
30	25.10.2017	372.00	232.00	125.00	232.00	7.32	40.00	29.00	88.00	5.10	7.68	-	-	
माह का औसत		338.70	230.83	139.40	236.00	7.28	36.87	26.40	70.13	4.99	7.61	1.87	1.33	

लखनऊ नगर के गोमती कार्य योजना द्वितीय चरण के अन्तर्गत सीवेज शोधन संयंत्रों की दैनिक परफार्मेन्स की मासिक सूचना

माह नवम्बर, 2017 की प्रगति सूचना

प्रपत्र-4(ii)

नगर का नाम : लखनऊ

सीवेज ट्रीटमेन्ट प्लान्ट का नाम व टेक्नालाजी : भरवारा एस0टी0पी0, यूएएसबी टेक्नालाजी

सीवेज ट्रीटमेन्ट प्लान्ट की क्षमता : 345 एम.एल.डी.

एफ्लूएण्ट का निस्तारण : गोमती नदी

क्र. सं.	दिनांक	एस.टी.पी. पर प्राप्त सीवेज की मात्रा (एम.एल.डी.)	इनफ्लूएन्ट				एफ्लूएन्ट					प्रतिदिन पावरकट (मिनट)	प्रतिदिन DG सेट चलाया गया (मिनट)	टिप्पणी
			टी.एस.एस. (मि.ग्रा./ली.)	बी.ओ.डी. (मि.ग्रा./ली.)	सी.ओ.डी. (मिग्रा/ली.)	पी.एच.	टी.एस.एस. (मि.ग्रा./ली.)	बी.ओ.डी. (मि.ग्रा./ली.)	सी.ओ.डी. (मि.ग्रा./ली.)	डी.ओ. (मि.ग्रा./ली.)	पी.एच.			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	26.10.2017	355.00	216.00	135.00	224.00	7.28	37.00	26.00	68.00	5.00	7.61			
2	27.10.2017	353.00	220.00	133.00	232.00	7.25	34.00	27.00	56.00	4.90	7.60			
3	28.10.2017	318.00	226.00	135.00	224.00	7.29	36.00	26.00	64.00	5.10	7.63			
4	29.10.2017	332.00	231.00	130.00	240.00	7.33	35.00	25.00	72.00	5.00	7.58			
5	30.10.2017	334.00	226.00	140.00	256.00	7.31	37.00	27.00	80.00	4.90	7.61			
6	31.10.2017	348.00	229.00	133.00	240.00	7.34	34.00	26.00	64.00	5.00	7.64			
7	01.11.2017	363.00	218.00	138.00	248.00	7.30	31.00	28.00	72.00	4.90	7.59			
8	02.11.2017	343.00	223.00	135.00	236.00	7.32	33.00	25.00	80.00	5.00	7.58			
9	03.11.2017	352.00	216.00	125.00	228.00	7.28	35.00	27.00	72.00	4.90	7.56			
10	04.11.2017	387.00	220.00	133.00	224.00	7.32	37.00	25.00	64.00	4.90	7.59			Permissible
11	05.11.2017	380.00	226.00	130.00	232.00	7.26	39.00	24.00	80.00	5.00	7.63			limit of Effluent
12	06.11.2017	341.00	230.00	140.00	224.00	7.31	42.00	26.00	64.00	5.10	7.66			D.O.>4.0 mg/l
13	07.11.2017	376.00	218.00	135.00	220.00	7.35	38.00	25.00	88.00	5.00	7.64			BOD<30 mg/l
14	08.11.2017	371.00	216.00	140.00	228.00	7.29	37.00	27.00	80.00	5.10	7.61			COD<100 mg/l
15	09.11.2017	349.00	225.00	138.00	232.00	7.35	40.00	26.00	72.00	5.00	7.60			TSS<50 mg/l
16	10.11.2017	365.00	219.00	153.00	252.00	7.31	36.00	25.00	80.00	4.90	7.62			p^H = 7-8
17	11.11.2017	358.00	238.00	145.00	256.00	7.27	35.00	27.00	64.00	5.00	7.58			
18	12.11.2017	373.00	229.00	150.00	240.00	7.29	38.00	26.00	72.00	4.90	7.61			
19	13.11.2017	337.00	220.00	143.00	232.00	7.34	34.00	28.00	60.00	5.00	7.57			
20	14.11.2017	359.00	226.00	148.00	240.00	7.28	37.00	25.00	64.00	5.00	7.62			
21	15.11.2017	260.00	232.00	140.00	224.00	7.30	40.00	27.00	80.00	5.10	7.60			
22	16.11.2017	265.00	236.00	143.00	232.00	7.27	36.00	26.00	72.00	5.00	7.59			
23	17.11.2017	322.00	228.00	135.00	240.00	7.32	38.00	28.00	60.00	5.10	7.61			
24	18.11.2017	365.00	225.00	133.00	220.00	7.40	34.00	25.00	72.00	5.00	7.68			
25	19.11.2017	369.00	221.00	148.00	240.00	7.35	36.00	27.00	80.00	5.10	7.65			
26	20.11.2017	365.00	216.00	138.00	220.00	7.39	33.00	24.00	80.00	5.00	7.61			
27	21.11.2017	363.00	231.00	135.00	240.00	7.30	36.00	26.00	88.00	4.90	7.57			
28	22.11.2017	348.00	219.00	130.00	228.00	7.42	34.00	25.00	68.00	5.10	7.70			
29	23.11.2017	358.00	215.00	125.00	224.00	7.38	32.00	27.00	60.00	5.20	7.72			
30	24.11.2017	352.00	221.00	128.00	232.00	7.35	35.00	28.00	80.00	5.00	7.66			
31	25.11.2017	338.00	228.00	138.00	240.00	7.32	33.00	26.00	64.00	5.10	7.69			
माह का औसत		348.35	224.00	137.16	233.81	7.32	35.87	26.13	71.61	5.01	7.62	0.00	0.00	

लखनऊ नगर के गोमती कार्य योजना द्वितीय चरण के अन्तर्गत सीवेज शोधन संयंत्रों की दैनिक परफार्मेन्स की मासिक सूचना

माह दिसम्बर, 2017 की प्रगति सूचना

प्रपत्र-4(ii)

नगर का नाम : लखनऊ

सीवेज ट्रीटमेन्ट प्लान्ट का नाम व टेक्नालाजी : भरवारा एस0टी0पी0, यूएएसबी टेक्नालाजी

सीवेज ट्रीटमेन्ट प्लान्ट की क्षमता : 345 एम.एल.डी.

एफ्लूएण्ट का निस्तारण : गोमती नदी

क्र. सं.	दिनांक	एस.टी.पी. पर प्राप्त सीवेज की मात्रा (एम.एल.डी.)	इनफ्लूएन्ट				एफ्लूएन्ट					प्रतिदिन पावरकट (मिनट)	प्रतिदिन DG सेट चलाया गया (मिनट)	टिप्पणी
			टी.एस.एस. (मि.ग्रा./ली.)	बी.ओ.डी. (मि.ग्रा./ली.)	सी.ओ.डी. (मिग्रा/ली.)	पी.एच.	टी.एस.एस. (मि.ग्रा./ली.)	बी.ओ.डी. (मि.ग्रा./ली.)	सी.ओ.डी. (मि.ग्रा./ली.)	डी.ओ. (मि.ग्रा./ली.)	पी.एच.			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	26.11.2017	334.00	217.00	135.00	224.00	7.38	36.00	25.00	72.00	5.20	7.65	-	-	
2	27.11.2017	333.00	224.00	135.00	232.00	7.35	38.00	27.00	76.00	5.00	7.60	-	-	
3	28.11.2017	337.00	218.00	130.00	240.00	7.41	37.00	26.00	80.00	4.90	7.62	-	-	
4	29.11.2017	364.00	225.00	150.00	256.00	7.36	35.00	28.00	88.00	5.00	7.59	-	-	
5	30.11.2017	364.00	228.00	145.00	248.00	7.30	38.00	27.00	72.00	4.90	7.57	-	-	
6	01.12.2017	355.00	219.00	140.00	244.00	7.42	40.00	25.00	68.00	5.00	7.67	-	-	
7	02.12.2017	348.00	224.00	135.00	232.00	7.34	41.00	28.00	80.00	4.90	7.58	-	-	
8	03.12.2017	356.00	231.00	148.00	240.00	7.36	37.00	26.00	72.00	5.00	7.62	-	-	
9	04.12.2017	363.00	217.00	150.00	248.00	7.32	37.00	27.00	76.00	4.90	7.61	-	-	
10	05.12.2017	344.00	221.00	143.00	236.00	7.36	35.00	25.00	72.00	5.00	7.58	-	-	Permissible
11	06.12.2017	354.00	215.00	135.00	228.00	7.39	38.00	28.00	80.00	4.90	7.56	-	-	limit of Effluent
12	07.12.2017	284.00	235.00	150.00	256.00	7.36	42.00	26.00	88.00	5.00	7.58	-	-	D.O.>4.0 mg/l
13	08.12.2017	333.00	229.00	155.00	260.00	7.40	40.00	28.00	96.00	4.90	7.63	-	-	BOD<30 mg/l
14	09.12.2017	338.00	219.00	145.00	232.00	7.43	42.00	25.00	80.00	5.10	7.61	95.00	90.00	COD<100 mg/l
15	10.12.2017	351.00	226.00	150.00	240.00	7.40	38.00	27.00	72.00	5.20	7.69	-	-	TSS<50 mg/l
16	11.12.2017	360.00	217.00	140.00	224.00	7.45	39.00	26.00	80.00	5.00	7.66	-	-	p^H = 7-8
17	12.12.2017	340.00	235.00	135.00	232.00	7.39	37.00	28.00	72.00	5.20	7.68	170.00	165.00	
18	13.12.2017	353.00	216.00	143.00	236.00	7.46	33.00	25.00	80.00	5.10	7.68	-	-	
19	14.12.2017	353.00	219.00	140.00	224.00	7.43	38.00	26.00	64.00	5.30	7.65	100.00	90.00	
20	15.12.2017	354.00	234.00	145.00	240.00	7.45	39.00	28.00	76.00	5.10	7.66	185.00	180.00	
21	16.12.2017	359.00	226.00	138.00	232.00	7.40	35.00	25.00	68.00	5.20	7.68	-	-	
22	17.12.2017	370.00	217.00	135.00	224.00	7.37	37.00	27.00	72.00	5.00	7.62	-	-	
23	18.12.2017	363.00	223.00	130.00	228.00	7.42	34.00	26.00	64.00	4.90	7.67	-	-	
24	19.12.2017	375.00	214.00	128.00	240.00	7.44	32.00	24.00	60.00	5.20	7.68	-	-	
25	20.12.2017	359.00	216.00	133.00	224.00	7.42	37.00	26.00	72.00	5.10	7.66	-	-	
26	21.12.2017	371.00	228.00	135.00	236.00	7.46	40.00	28.00	80.00	5.20	7.68	-	-	
27	22.12.2017	346.00	221.00	130.00	232.00	7.39	36.00	27.00	64.00	5.10	7.67	-	-	
28	23.12.2017	317.00	217.00	148.00	224.00	7.36	40.00	25.00	88.00	4.90	7.62	-	-	
29	24.12.2017	371.00	234.00	150.00	244.00	7.43	37.00	29.00	80.00	5.10	7.65	-	-	
30	25.12.2017	352.00	221.00	145.00	232.00	7.45	39.00	27.00	72.00	5.20	7.70	-	-	
माह का औसत		350.03	222.87	140.70	236.27	7.40	37.57	26.50	75.47	5.05	7.64	18.33	17.50	

लखनऊ नगर के गोमती कार्य योजना द्वितीय चरण के अन्तर्गत सीवेज शोधन संयंत्रों की दैनिक परफार्मेन्स की मासिक सूचना

माह जनवरी, 2018 की प्रगति सूचना

प्रपत्र-4(ii)

नगर का नाम : लखनऊ

सीवेज ट्रीटमेन्ट प्लान्ट का नाम व टेक्नालाजी : भरवारा एस0टी0पी0, यूएएसबी टेक्नालाजी

सीवेज ट्रीटमेन्ट प्लान्ट की क्षमता : 345 एम.एल.डी.

एफ्लूएण्ट का निस्तारण : गोमती नदी

क्र. सं.	दिनांक	एस.टी.पी. पर प्राप्त सीवेज की मात्रा (एम.एल.डी.)	इनफ्लूएन्ट				एफ्लूएन्ट					प्रतिदिन पावरकट (मिनट)	प्रतिदिन DG सेट चलाया गया (मिनट)	टिप्पणी
			टी.एस.एस. (मि.ग्रा./ली.)	बी.ओ.डी. (मि.ग्रा./ली.)	सी.ओ.डी. (मिग्रा/ली.)	पी.एच.	टी.एस.एस. (मि.ग्रा./ली.)	बी.ओ.डी. (मि.ग्रा./ली.)	सी.ओ.डी. (मि.ग्रा./ली.)	डी.ओ. (मि.ग्रा./ली.)	पी.एच.			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	26.12.2017	389	218	143	240	7.41	35	26	88	5	7.59	-	-	
2	27.12.2017	383	234	138	248	7.39	38	27	80	5.1	7.67	-	-	
3	28.12.2017	377	238	150	256	7.43	40	25	88	5	7.62	-	-	
4	29.12.2017	372	229	145	248	7.4	37	28	72	5.2	7.69	-	-	
5	30.12.2017	371	224	138	240	7.45	39	26	80	5.2	7.72	-	-	
6	31.12.2017	390	227	143	236	7.42	35	27	64	5.3	7.74	-	-	
7	01.01.2018	367	215	140	224	7.45	36	25	72	5.2	7.66	-	-	
8	02.01.2018	368	225	133	232	7.44	38	28	88	5.4	7.66	-	-	
9	03.01.2018	336	229	135	240	7.41	37	27	80	5.3	7.63	-	-	
10	04.01.2018	371	218	130	228	7.45	34	26	76	5.4	7.59	-	-	Permissible
11	05.01.2018	364	234	128	248	7.47	39	28	72	5.2	7.64	-	-	limit of Effluent
12	06.01.2018	366	216	130	256	7.43	35	25	64	5.3	7.61	-	-	D.O.>4.0 mg/l
13	07.01.2018	358	236	138	264	7.4	37	25	80	5	7.57	-	-	BOD<30 mg/l
14	08.01.2018	374	212	145	272	7.45	38	24	88	5.2	7.66			COD<100 mg/l
15	09.01.2018	371	207	135	280	7.43	45	27	92	5.1	7.67	-	-	TSS<50 mg/l
16	10.01.2018	366	210	128	268	7.48	38	28	72	5.2	7.68	-	-	p^H = 7-8
17	11.01.2018	371	215	145	264	7.5	39	24	80	5.3	7.68			
18	12.01.2018	372	209	150	256	7.52	44	26	88	5.2	7.66	-	-	
19	13.01.2018	371	206	148	256	7.48	35	28	72	5	7.64			
20	14.01.2018	365	212	140	248	7.49	41	27	80	5.1	7.67			
21	15.01.2018	345	216	145	280	7.45	36	25	88	5	7.63	-	-	
22	16.01.2018	360	221	143	288	7.41	46	26	80	5.1	7.6	-	-	
23	17.01.2018	351	209	150	292	7.44	46	28	92	5	7.58	-	-	
24	18.01.2018	361	214	135	272	7.46	48	27	84	4.9	7.61	-	-	
25	19.01.2018	337	208	143	264	7.43	45	25	88	5	7.59	-	-	
26	20.01.2018	337	227	138	272	7.45	47	28	80	5.1	7.55	-	-	
27	21.01.2018	350	216	135	260	7.42	44	26	72	4.9	7.58	16.00	15.00	
28	22.01.2018	350	231	148	268	7.42	42	27	88	5	7.61	327.00	334.00	
29	23.01.2018	333	242	140	264	7.46	38	25	76	5	7.64	21.00	20.00	
30	24.01.2018	346	227	133	272	7.48	42	28	72	5.1	7.62	-	-	
31	25.01.2018	331	238	135	280	7.45	45	26	88	5	7.59	28.00	25.00	
माह का औसत		361.39	221.39	139.58	258.58	7.44	39.97	26.39	80.13	5.12	7.63	12.65	12.71	

लखनऊ नगर के गोमती कार्य योजना द्वितीय चरण के अन्तर्गत सीवेज शोधन संयंत्रों की दैनिक परफामेन्स की मासिक सूचना
माह फरवरी, 2018 की प्रगति सूचना

प्रपत्र-4(ii)

नगर का नाम : लखनऊ
सीवेज ट्रीटमेन्ट प्लान्ट का नाम व टेक्नालाजी : **भरवारा एस0टी0पी0, यूएएसबी टेक्नालाजी**
सीवेज ट्रीटमेन्ट प्लान्ट की क्षमता : **345 एम.एल.डी.**
एफ्लूएण्ट का निस्तारण : गोमती नदी

क्र. सं.	दिनांक	एस.टी.पी. पर प्राप्त सीवेज की औसत मात्रा (एम.	इनफ्लूएन्ट				एफ्लूएन्ट					प्रतिदिन पावरकट (मिनट)	प्रतिदिन DG सेट चलाया गया (मिनट)	टिप्पणी
			टी.एस.एस. (मि.ग्रा./ली.)	बी.ओ.डी. (मि.ग्रा./ली.)	सी.ओ.डी. (मिग्रा/ली.)	पी.एच.	टी.एस.एस. (मि.ग्रा./ली.)	बी.ओ.डी. (मि.ग्रा./ली.)	सी.ओ.डी. (मि.ग्रा./ली.)	डी.ओ. (मि.ग्रा./ली.)	पी.एच.			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	26.01.2018	357.00	225.00	148.00	256.00	7.47	41.00	28.00	72.00	5.20	7.65	-	-	
2	27.01.2018	359.00	230.00	140.00	264.00	7.43	37.00	27.00	68.00	5.00	7.63	-	-	
3	28.01.2018	362.00	223.00	150.00	272.00	7.45	39.00	25.00	80.00	5.10	7.60	-	-	
4	29.01.2018	315.00	220.00	138.00	256.00	7.46	36.00	26.00	64.00	4.90	7.58	-	-	
5	30.01.2018	309.00	231.00	135.00	268.00	7.44	35.00	28.00	72.00	5.00	7.64	-	-	
6	31.01.2018	307.00	224.00	145.00	264.00	7.46	38.00	25.00	88.00	5.10	7.60	332.00	330.00	
7	01.02.2018	350.00	237.00	135.00	272.00	7.42	40.00	29.00	80.00	5.00	7.65	342.00	340.00	
8	02.02.2018	355.00	231.00	143.00	260.00	7.45	37.00	27.00	68.00	4.90	7.62	-	-	
9	03.02.2018	363.00	228.00	150.00	280.00	7.40	42.00	26.00	72.00	5.00	7.57	-	-	
10	04.02.2018	364.00	243.00	153.00	288.00	7.38	36.00	28.00	80.00	4.90	7.62	266.00	265.00	Permissible
11	05.02.2018	341.00	246.00	140.00	280.00	7.41	38.00	25.00	72.00	5.00	7.63	-	-	limit of Effluent
12	06.02.2018	341.00	229.00	135.00	272.00	7.44	42.00	27.00	76.00	4.90	7.59	-	-	D.O.>4.0 mg/l
13	07.02.2018	340.00	234.00	130.00	276.00	7.46	35.00	26.00	88.00	5.10	7.58	-	-	BOD<30 mg/l
14	08.02.2018	353.00	226.00	143.00	264.00	742.00	37.00	24.00	68.00	5.00	7.62	357.00	355.00	COD<100 mg/l
15	09.02.2018	351.00	218.00	150.00	256.00	7.45	36.00	25.00	72.00	5.10	7.65	-	-	TSS<50 mg/l
16	10.02.2018	326.00	230.00	155.00	272.00	7.48	39.00	29.00	80.00	5.00	7.68	-	-	p^H = 7-8
17	11.02.2018	350.00	236.00	148.00	280.00	7.43	41.00	26.00	88.00	5.10	7.64	124.00	120.00	
18	12.02.2018	366.00	225.00	145.00	276.00	7.46	37.00	28.00	68.00	4.90	7.61	28.00	25.00	
19	13.02.2018	380.00	232.00	150.00	288.00	7.40	35.00	25.00	72.00	5.00	7.63			
20	14.02.2018	340.00	275.00	155.00	296.00	7.37	37.00	25.00	64.00	4.90	7.56			
21	15.02.2018	350.00	245.00	143.00	288.00	7.42	38.00	27.00	80.00	5.10	7.61	-	-	
22	16.02.2018	340.00	234.00	140.00	272.00	7.39	36.00	25.00	88.00	5.00	7.64	-	-	
23	17.02.2018	356.00	227.00	150.00	264.00	7.44	39.00	28.00	72.00	5.20	7.67	-	-	
24	18.02.2018	389.00	231.00	143.00	276.00	7.41	37.00	26.00	64.00	5.10	7.59	-	-	
25	19.02.2018	390.00	224.00	138.00	248.00	7.45	41.00	24.00	80.00	5.00	7.62	37.00	35.00	
26	20.02.2018	373.00	235.00	145.00	272.00	7.37	40.00	27.00	88.00	4.90	7.58	-	-	
27	21.02.2018	405.00	221.00	145.00	264.00	7.41	44.00	25.00	72.00	5.00	7.63			
28	22.02.2018	405.00	227.00	140.00	256.00	7.43	41.00	26.00	80.00	5.00	7.65			
29	23.02.2018	402.00	219.00	135.00	268.00	7.43	39.00	24.00	76.00	4.90	7.61			
30	24.02.2018	350.00	230.00	148.00	272.00	7.45	42.00	28.00	84.00	5.10	7.64	-	-	
31	25.02.2018	354.00	225.00	153.00	264.00	7.40	38.00	27.00	68.00	5.00	7.59			
माह का औसत		356.23	231.00	144.13	270.45	31.12	38.48	26.32	75.61	5.01	7.62	47.94	47.42	

लखनऊ नगर के गोमती कार्य योजना द्वितीय चरण के अन्तर्गत सीवेज शोधन संयंत्रों की दैनिक परफामेन्स की मासिक सूचना
माह मार्च, 2018 की प्रगति सूचना

प्रपत्र-4(ii)

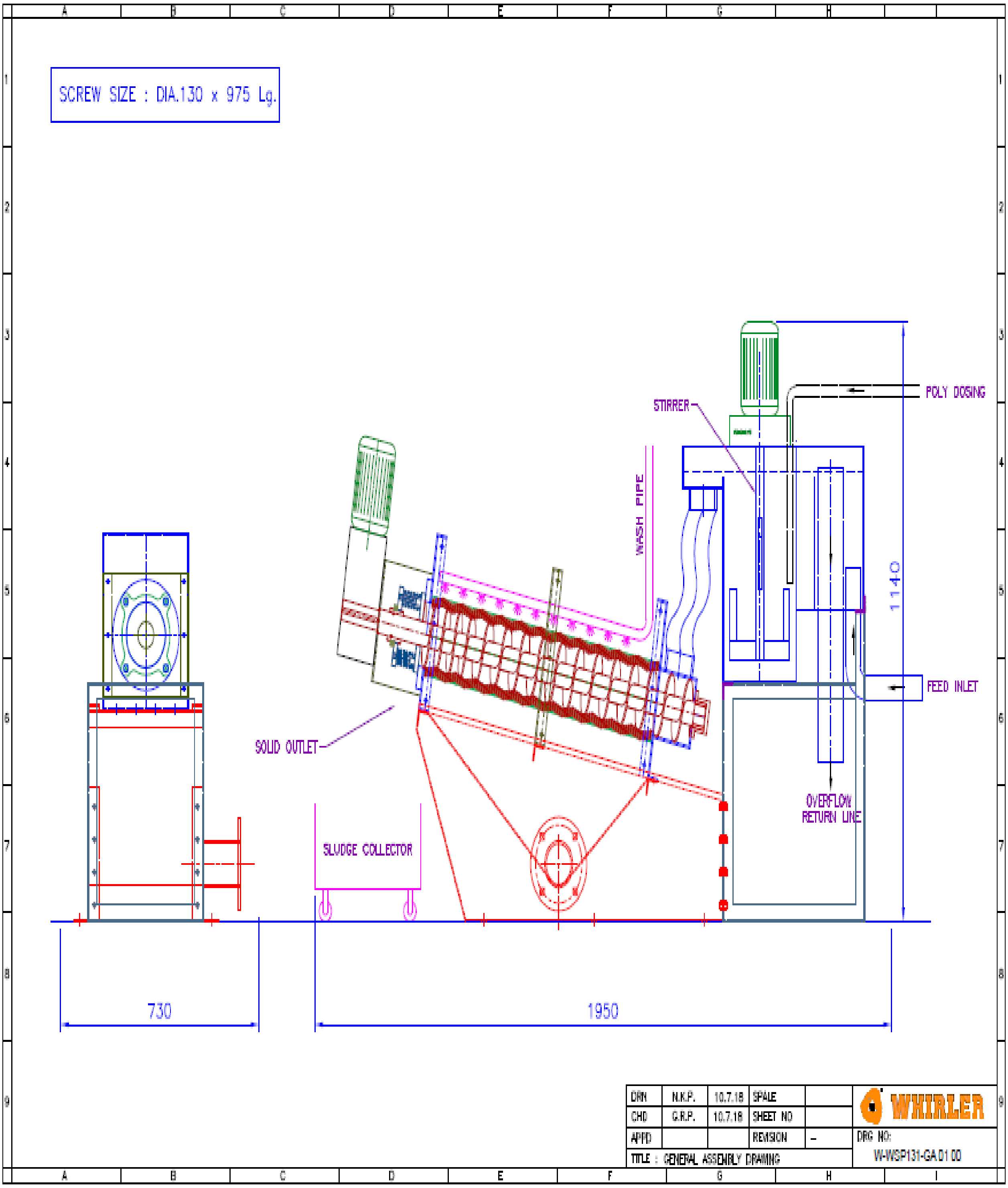
नगर का नाम : लखनऊ
सीवेज ट्रीटमेन्ट प्लान्ट का नाम व टेक्नालाजी : **भरवारा एस0टी0पी0, यूएएसबी टेक्नालाजी**
सीवेज ट्रीटमेन्ट प्लान्ट की क्षमता : **345 एम.एल.डी.**
एफ्लूएण्ट का निस्तारण : गोमती नदी

क्र. सं.	दिनांक	एस.टी.पी. पर प्राप्त सीवेज की औसत मात्रा (एम.	इनफ्लूएन्ट				एफ्लूएन्ट					प्रतिदिन पावरकट (मिनट)	प्रतिदिन DG सेट चलाया गया (मिनट)	टिप्पणी
			टी.एस.एस. (मि.ग्रा./ली.)	बी.ओ.डी. (मि.ग्रा./ली.)	सी.ओ.डी. (मिग्रा/ली.)	पी.एच.	टी.एस.एस. (मि.ग्रा./ली.)	बी.ओ.डी. (मि.ग्रा./ली.)	सी.ओ.डी. (मि.ग्रा./ली.)	डी.ओ. (मि.ग्रा./ली.)	पी.एच.			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	26.02.2018	370.00	235.00	145.00	280.00	7.36	43.00	25.00	88.00	5.10	7.61	-	-	
2	27.02.2018	367.00	223.00	150.00	272.00	7.38	39.00	26.00	80.00	5.00	7.58	-	-	
3	28.02.2018	380.00	218.00	140.00	256.00	7.41	37.00	28.00	72.00	5.10	7.64	-	-	
4	01.03.2018	359.00	226.00	155.00	272.00	7.45	39.00	26.00	68.00	5.00	7.65	-	-	
5	02.03.2018	369.00	228.00	153.00	280.00	7.42	40.00	26.00	80.00	4.90	7.63	-	-	
6	03.03.2018	380.00	266.00	163.00	312.00	7.38	43.00	27.00	96.00	4.80	7.60	-	-	
7	04.03.2018	342.00	244.00	160.00	288.00	7.34	38.00	28.00	80.00	5.10	7.61	22.00	20.00	
8	05.03.2018	310.00	262.00	160.00	280.00	7.39	36.00	25.00	72.00	5.30	7.63	-	-	
9	06.03.2018	329.00	264.00	163.00	296.00	7.35	35.00	27.00	88.00	5.40	7.69	-	-	
10	07.03.2018	379.00	270.00	155.00	284.00	7.39	38.00	26.00	80.00	5.20	7.65	9.00	8.00	Permissible
11	08.03.2018	382.00	253.00	150.00	272.00	7.34	36.00	25.00	68.00	5.30	7.62	-	-	limit of Effluent
12	09.03.2018	385.00	245.00	160.00	280.00	7.36	38.00	28.00	72.00	5.20	7.60	-	-	D.O.>4.0 mg/l
13	10.03.2018	377.00	242.00	140.00	264.00	7.40	40.00	25.00	80.00	5.00	7.64	-	-	BOD<30 mg/l
14	11.03.2018	350.00	235.00	135.00	276.00	7.37	37.00	27.00	68.00	5.10	7.61	-	-	COD<100 mg/l
15	12.03.2018	373.00	248.00	133.00	268.00	7.35	35.00	26.00	72.00	5.30	7.78	-	-	TSS<50 mg/l
16	13.03.2018	353.00	238.00	130.00	272.00	7.38	34.00	25.00	80.00	5.20	7.72	-	-	p^H = 7-8
17	14.03.2018	360.00	232.00	135.00	264.00	7.41	37.00	28.00	76.00	5.00	7.68	-	-	
18	15.03.2018	376.00	240.00	128.00	260.00	7.40	43.00	25.00	64.00	5.10	7.64	-	-	
19	16.03.2018	389.00	229.00	133.00	272.00	7.37	39.00	27.00	80.00	5.00	7.62	-	-	
20	17.03.2018	369.00	222.00	145.00	280.00	7.40	40.00	26.00	72.00	5.10	7.65	-	-	
21	18.03.2018	370.00	237.00	140.00	268.00	7.44	38.00	25.00	84.00	5.30	7.68	-	-	
22	19.03.2018	389.00	227.00	143.00	288.00	7.42	36.00	28.00	80.00	5.10	7.64	-	-	
23	20.03.2018	366.00	219.00	135.00	264.00	7.39	35.00	26.00	72.00	5.00	7.68	-	-	
24	21.03.2018	359.00	229.00	145.00	272.00	7.36	39.00	24.00	76.00	5.10	7.65	-	-	
25	22.03.2018	374.00	223.00	148.00	288.00	7.40	36.00	26.00	80.00	5.10	7.66	-	-	
26	23.03.2018	374.00	220.00	138.00	260.00	7.43	37.00	25.00	68.00	5.00	7.69	-	-	
27	24.03.2018	379.00	231.00	145.00	268.00	7.37	34.00	27.00	72.00	5.10	7.65	-	-	
28	25.03.2018	381.00	225.00	140.00	256.00	7.42	36.00	25.00	80.00	5.20	7.67	-	-	
माह का औसत		367.54	236.82	145.25	274.71	7.39	37.79	26.14	76.71	5.11	7.65	1.11	1.00	

Annexure 2: Quotations for mechanized solid–liquid separation

Vendor 1: Screw Press

2.1 Design layout of Screw Press



2.2 Cost of Screw Press

CIN No.: U29199GJ1990PTC014284

Mail : info@whirlercentrifugals.com
Web : www.whirlercentrifugals.com
M.: +91 8264365693, +91 94264 19038

Whirler Centrifugals Pvt. Ltd.

Works : Plot No.-1213, Phase - III, G.I.D.C. Estate, Vatva, Ahmedabad - 382 445 (Guj.) INDIA. Ph. : +91 90330 39304

Ref:WCPL/WSP/18-19/R7 Dt. 02.01.2019

Dear Sir,

Thank you very much for your kind inquiry for "Whirler Screw Press". Please find here below our offer/price list for your kind consideration.

" Whirler" Screw Press

Model	Capacities		Power	Price INR	
	Feed Capacity m3/Hr	Solid Output Kg/Hr @22% Solid Content	(HP)	SS 316	SS 304
WSP 201	4	200	1	11,70,000.00	10,00,000.00
WSP 202	8	400	1.5	20,80,000.00	17,80,000.00

Terms & Conditions:

Price	Ex-works at Ahmadabad basis in unpacked condition.
Tax	GST @ 18 % EXTRA.
Payment	50% of the order value as advance along with confirmed order, balance before dispatch against proforma invoice.
Delivery	8 to 10 week from the date of receipt of your P.O. with advance.
Packing and Forwarding	2% Extra Packing, Forwarding & Transportation at Actual on To-Pay Basis.

CIN No.: U29199GJ1990PTC014284
Mail : info@whirlercentrifugals.com
Web : www.whirlercentrifugals.com
M.: +91 8264365693, +91 94264 19038
Whirler Centrifugals Pvt. Ltd.
Works : Plot No.-1213, Phase - III, G.I.D.C. Estate, Vatva, Ahmedabad - 382 445 (Guj.) INDIA. Ph. : +91 90330 39304

DATASHEET OF SCREW PRESS

Model	Screw Size (mm)		No. of Screw	Feed Capacity m3/Hr	Solid Output Kg/Hr	No. of Mixing Motors	Power (HP)
	Dia	Length		m3/hr	22% Solid Content		
WSP 201	200	1500	1	4	200	1	1
WSP 202	200	1500	2	8	400	1	1.5

Scope of supply:

Whirler's Scope	Client's Scope
For Screw Press	
Screw Press machine	All electric Wiring
Electric Motor	All Pipe work for Feeding
VFD Control panel	Feed Pump
Inlet Point for dosing	All necessary arrangement for Online Dosing
Foundation drawing	All civil work for Foundation
Supervisory support for first run.	Erection and commissioning.

284
m
m
4 19038 Whirler Centrifugals Pvt. Ltd.

Works : Plot No.-1213, Phase - III, G.I.D.C. Estate, Vatva, Ahmedabad - 382 445 (Guj.) INDIA. Ph. : +91 90330 39304

re not responsible for any damages/leakages during
sportation. If required you are requested to take transport
rance at extra cost.

se mention all important technical details in your P.O. in
; manner to allow us to serve you better.
se check suitability of our product as per your
irement, you can consult us about any technical details,
ime, before placing the order.

: prices are final and negotiable only for changing in
ical and/or financial terms.
rovide warranty for 18 month from the date of dispatch, or,
nth from the date of installation, whichever is earlier.
warranty is limited to make necessary changes to make our
ine in running condition. For out of station
allation/service (apart from Ahmadabad), client needs to
ide adequate boarding, lodging and transportation facility
or cost.

ou will find our offer most reasonable and oblige us with
ed order. However, if you want to get any other details /
n please do not hesitate to write on us.

or your favourable reply. For further technical or
queries please write to us.

egards,

L.
WHIRLER CENTRIFUGALS PVT LTD
and Suppliers of *ISO 9001:2008 Quality Products*
uum Pumps and Fluid Couplings
entrifuges and Laundry Machineries
3, PHASE 3 , GIDC Estate, VATVA,
– 382 445, India.

nquiries at E-mail: info@whirlercentrifugals.com
catalog at Web: www.whirlercentrifugals.com
keting: Mobile: 09426419038, 08264365693

Vendor 2: Screw Press

CCP ENTERPRISES

No 404 Sentosa Pearl Bulding waked Pune Maharashtra.
Email: ccp.enterprises1@gmail.com, pravin1747@gmail.com

CCP/O/2018/879 Date: 03-01-20

To,
Urban Water Waste Management
Centre for Science and Environment,
New Delhi

Kind Attn : Mr. Hemant Arora
Sub : Offer for SCREW PRESS Model CCP 301
Ref : Our discussion and your email on dated 2nd Jan 2019.

Dear Sir,
This refers to your enquiry regarding bag dewatering unit kindly find our offer for below Sludge details.

Selected Model	CCP 103	Quantity	One
Capacity at inlet	5 m^3 / Hr. at sludge concentration of 1.5%	Solid at outlet	@ 20 ±2%

Thanking You

Pravin Raut

CCP ENTERPRISES

No 404 Sentosa Pearl Bulding waked Pune Maharashtra.
Email:ccp.enterprises1@gmail.com, pravin1747@gmail.com

A)	**SCOPE OF SUPPLY AND PRICE SCHEDULE:**			
	Description	**Unit rate**	**Qty.**	**Price in Rs Ex work Pune**
1)	Supply of one SLUDGE DEWATERING SCREW PRESS MACHINE MODEL 301 WITHOUT ELECTRICAL CONTROL PANEL Slurry handling capacity : 5 m3/hr at 1.5 % solid specification as per annexure I	-	One	**INR : 34,94,000/-** **(INR : Thirty Four lakh** **Ninety Four Thousand only** **)**
2)	**ERECTION & COMMISSIONING:**			
	Charges for offering supervision of Erection and Commission activity. Note: To & fro traveling by AC air / train , lodging & boarding, local conveyance, extra to your account.			Rs. 5000 / - per man-day. **INR : Five Thousand Only**

ANNEXURE 1

ITEM		SPECIFICATION
Dimensions L X W X H		4100mm X 1100mm X 2200mm
Total Power		2.0 HP
Power Supply		440 V /50 Hz 3 phase.
Thickening cum compaction cylinder	Diameter /Length	Dia.350mm/2150 mm long 1 Nos.
	Material	Nylon in thickening zone and SS304 in pressure zone
	Quantity	One
Screw Motor 1 nos.	Model	Standard TEFC SCR induction motor
	Make	Kirloskar/ Crompton / Bharat Bijlee / Rotomotive/Siemens
	Power	1.5 HP
	Quantity	One
	Operation	Controlled by VFD.
Flocculation Tank	Dimensions	770mm X 770mm X 1000mm
	Capacity	500 liter
	Material	SS 304
Flocculation Tank Agitation Motor	Model	Standard TEFC SCR induction motor
	Make	Kirloskar/ Crompton / Bharat Bijlee / Rotomotive/Siemens
	Power	0.5 HP
	Quantity	One
	Operation	Controlled by VFD
Screw gear box	Type	Heliworm
	Make	Power Build /Rotomotive
Floculator gear box	Type	Worm Reducer 30: 1
	Make	Rotomotive
Solonoid valve	Size	25 NB.
	Material	SS 304 / Brass
Control Panel (Client Scope)	Dimensions	800mm X 600mm X 250mm
	Material /paint	Low carbon steel powder coated
Showering System	Operation	Governed by cyclic timer 10 second /10 min
	Capacity	6 lpm each nozzle (160 ltr / hr.)

Client Scope of Supply:

- Poly electrolyte dosing system including chemical tank agitator & pump of 1000 LPH .
- Sludge Feed pump 18 m3/hr @ 10 meter head.
- Inter Connecting Piping & Fittings.
- Civil foundation required for equipment.
- Electrical connection upto equipment.
- Supply of unskilled man power in your scope.
- Lodging and boarding of service engineer will be in your scope.
- All necessary support for installation of machine is to be provided by you.

B)	**EXCLUSIONS FROM OUR SCOPE:**	
	Erection and commissioning, electrical wiring & cabling, civil work and foundation required, Feed pump/system, All interconnecting piping, upstream and downstream of the offered equipment. Polyelectrolyte dosing system, Any sort of Instrumentation and controls other than mentioned in our offer. Any other item/activity not specifically mentioned in our offer.	
C]	**TERMS & CONDITIONS:**	
1)	Price basis	: Ex Work pune
2)	Packing	: 4 % extra.
3)	GST	: Extra as Applicable / As applicable at the time dispatch. @ 18 %
4)	Payment	: 60 % Advance along with order and balance 40 % with all taxes and duties against proforma invoice prior to dispatch
5)	Octroi, Transpoprt Insurance	: Extra as applicable. To your account
7)	Delivery Schedule	: 6 to 8 week from the date of receipt of your P.O. with advance.
8)	Warranty	: The equipment offered is guaranteed against manufacturing defects and faulty workmanship for a period of 12 months from commissioning or 15 months from the date of dispatch, which ever is earlier. Our liability will be restricted to repairs and replacement of defective parts only. However, this warranty does not cover electrical and / or instrumentation and such items and components, which are subject to normal wear & tear as also the cases of willful damage and / or negligence are also excluded from this warranty.
9)	Validity of the offer	: 30 days from the date of this offer.
10)	Order cancellation	: Order received and acknowledged by the seller shall not be subject to cancellation either wholly or partly for any reason whatsoever without the seller's written consent : The amount already paid as advance will not be returned in case the order is cancelled in whole or in part
11)	Non-lifting of equipment	If the equipment is not lifted by the buyer within 15 days after intimation by us, that the equipment is ready, then the buyer will be liable to pay demurrage at a rate of 0.5% per week to a maximum of 10% of the total contract price for such delay before lifting of the equipment
12)	Consequential losses	: There shall be no liability for either party towards the other party for loss of production, loss of profit, loss of use, loss of contracts or for any other consequential or indirect loss whatsoever

13)	Force Majeure	: Our offer is subject to Force Majeure clause. We shall not be held responsible for any delay in execution of the work for causes beyond our control such as war, terrorist attack, bandh, revolution, and strike, epidemic, accidental fire, flood or any other act of God
14)	Jurisdiction	: Any legal dispute arising of the resultant contract will be subject to the jurisdiction of Pune Maharashtra courts in case the same is not settled mutually

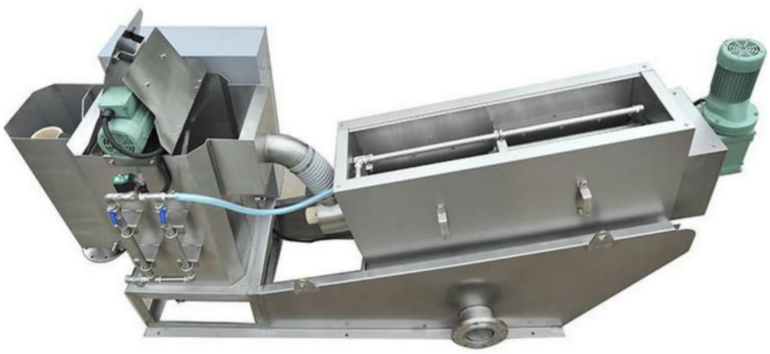
For

CCP Enterprises

Pravin Raut

8087317595

PHOTOGRAPH OF MACHINE



Vendor 3: Belt Filter Press

AMAR PLASTICS
Delivering Results

3220 - 21, Phase 3, GIDC, Chattral, Mehsana, Gujarat - 382 729, India.
Mo. :- 9825148477, E-Mail amarplastics93@yahoo.in, info@amarplastics.com
Web Site: www.amarplastics.com

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TECHNICAL DETAILS OF FILTER PRESS – 1200MMX 1200MM

Sr. No	DESCRIPTION	
1.	Plate Size	1200MM x 1200MM (48”) Open/close
2.	Total No. of Filter Press	01 Set
3.	Type of Element	P.P. Recessed
4.	Type of Delivery	Center feeding
5.	No. Of Recessed Plate	49 Pcs.
6.	Total No. Of Plates	49 Pcs. + 2 Pcs.
7.	Cake Thickness	40mm +/- 2mm
8.	Plate Thickness	70mm +/- 2mm
9.	Plate Material	Poly propylene
10.	Type of Discharge	Open/Close Delivery Type
11.	Filtration Area Per plate	App. 2.2 M. Sq.
12.	Total Filtration Area of Press	App. 110 M. Sq.
13.	Operating Pressure	5 Kg/cm2
14.	Max. Operating Pressure	7 Kg/cm2
15.	Moisture Content in Wet Cake	Its depend on pressure
16.	Feed Inlet Nozzle	01 Sets
	MATERIAL OF CONSTRUCTION	
17.	Feed Head	M.S. IS 2062 GRADE
18.	End Plate	M.S. IS 2062 GRADE
19.	Moving Plate	M.S. IS 2062 GRADE
20.	Filter Plates	P.P.White Virgin Quality
21.	Tie Bars	M.S.(S.S. Cladding on top side) M.S. Rail Size 250mm x 50mm
22.	Distance Piece	M.S.
23.	Filtrate Cocks	P.P. (Two Way)

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Sr no		Price Per Set
01	P.P. Filter Plate Size 1200mm x 1200mm having heavy duty M.S. Structure with M.S. Rail with Hydraulic Closing Device Operated by 2 Hp of Electric Motor of ABB/CG suitable to 51 pcs. Of 1200mm x 1200mm size with Filter Plate.	Rs.8,15,000/-

Note:
1) Our Scope does not supply of Sludge Pump/Pipe fittings ,Valves and Hydraulic Oil.
2) Our Scope does not include any civil work.
3) Our Scope does not include installation and commissioning of Machine. If you want it can provide you on Chargeable basis.

Terms & Conditions

a) Price : The prices Quoted above is ex. our Works.
b) Tax : 18% Charged will be extra GST.
c) Payment : 40% advance along with your order and balance against Performa Invoice.
d) Delivery : Within 03-04 Week from the date of your order letter.
e) Validity : 15days from the offer letter.

Thanking you,
Yours faithfully,
For Amar Plastics

Jainam Shah
+91-8320790187

Co-treatment is a process where a Sewage Treatment Plant, in addition to treating the domestic sewage transported through a sewerage city, also treats Faecal Sludge and Septage (FSS) emptied from various Onsite Sanitation Systems prevalent in the city. Co-Treatment of FSS in an STP is a good option for treatment of FSS in cities that are partially covered with sewerage network. However, in many cities in India, FSS is directly added without any pre-treatment, either at the inlet of the STP or at the nearest pumping station or manhole of the sewerage network. There are learnings from various countries on the detrimental impact of co-treatment of FSS in an STP without any pre-treatment. The considerably higher solids, organic and nutrient load of FSS as compared to sewage, can lead to severe operational problems such as solids deposition, clogging and corrosion of sewerage infrastructure, including STP. It is necessary to study the impact of co-treatment of FSS in the treatment efficiency of the STP as well as incorporating pre-treatment measures like Solid-Liquid separation to reduce the adverse impact of FSS in the STP treatment efficiency. The report provides a study of Bharwara STP in Lucknow and presents various options for co-treatment of FSS in the STP, which include mechanized and non-mechanized options.

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